
AUGMENTED PEDAGOGIES

Thesis submitted in accordance with the requirements of the
University of Liverpool for the degree of Doctor in Philosophy

by

Alejandro Andrés Veliz Reyes

November 2015

A mi familia

To my family

ACKNOWLEDGEMENTS

I have been lucky to count on great friends and colleagues to support and guide me during this PhD journey. A continuous company throughout this adventure has been the guidance, friendship and constant support of my supervisor Dr Tuba Kocaturk. I will be always deeply thankful for her help, which has gone beyond every expectation. Also, my thanks go to my co-supervisor Mr Michael Knight for his insights. Dr Riccardo Balbo and Professor Benachir Medjdoub have also taken the role of co-supervisor at some point. Their friendship and support have been fundamental for my work. Both, from different perspectives, have done a contribution without which this work could not be achieved.

My sincerest thanks are also with Professor Arto Kiviniemi and Professor David McClean, whom have generously used their time and expertise to review my work as internal and external reviewers, respectively.

Without the good will from several informants it would have been impossible to successfully complete this research as intended. Scholars, students and technical support staff have scaffolded this work with their openness and insights. Some initial explorations on the use of augmented reality for education were made in the MSc Digital Architectural Design at the University of Salford, with a teaching team formed by Dr Tuba Kocaturk, Professor Benachir Medjdoub and Dr Riccardo Balbo in the Design Directorate of the School of the Built Environment. The observational work at the Polytechnic of Turin was supported by an amazing group of anonymised academics who kindly gave me access to their design studio courses. The work conducted at the University of Liverpool was facilitated by a Higher Education Academy project implemented in a MA Architecture design studio course led by Dr Tuba Kocaturk and Mr Asterios Agkathidis, with the technical support of Mr Martin Winchester. Many other informants bravely let me observe and enquiry about their studio activities, including a group of instructors interviewed for the last stage of my work. Needless to say, without their contribution my dissertation would not have been possible and albeit their anonymous support, I cannot but acknowledge their time - you know who you are, thank you!

My research was initially funded by the Graduate Teaching Assistantship scheme of the University of Salford. This funding opportunity could not have been reached without the encouragement of my friend and colleague Luis Felipe González from

UTFSM who put me in the track of architectural research in the first place, in 2007. At the University of Liverpool I was supported by the BecasChile scheme for international doctoral studies, awarded by the Chilean National Commission for Scientific and Technological Research (CONICYT) in the Ministry of Education.

At the moment of finishing this dissertation I am lecturing Digital Design at the School of Architecture, Design and Environment of Plymouth University. My heartfelt gratitude to my patient colleagues and students who have given me much needed time and support during the last writing stage of this thesis. My special thanks go to my 1st and 2nd year BArch students, Professor Alessandro Aurigi, Professor Bob Brown, Ms Toshiko Terazono and Mr Andy Humphreys.

My thoughts are also with all those friends I've met throughout this journey: Ozlem, Yekta, Serhat, Andrea, Vincenzo, Clelie, Ela, Hani, Pooya, Rux, Mo, and many others. I must also mention my fellow Chileans, always there with their resilient chileanness and barbeques. My thanks go to Carola, Alejandro, Almendra and Lucas Hidalgo, as well as to the rest of the Chilean community in the North West of England. My thoughts are also with María Paz and Javiera for their company, motivation and counselling on demand whenever and wherever needed. Back in Chile, I have nothing but gratitude for the constant encouragement from Juan Francisco and Monse, Valeska, Ena and so many others.

Finally, this work is dedicated to my beloved family. Irene, Alejandro and Juan Pablo have been relentlessly encouraging me to keep striving towards this goal, regardless the long distance and time away from my far South.

ABSTRACT

Traditional institutions of the architectural design studio such as the design critique or the design jury are at the core of studio pedagogy. Yet, they have shifted and evolved over time towards what can be hardly defined as the typical master-apprentice “atelier” praxis anymore. Design studio pedagogy, deeply rooted into our disciplinary ethos, is under pressure due to a series of factors such as new industry demands, ever-evolving technologies or the diversification of architecture’s collaborative contexts of practice. While the design studio comprises a series of cultural, social, technological and educational mutually interdependent dimensions, this research specifically focuses on **technology-mediated teaching and learning communication**. By following a grounded theory approach, this work attempts to formalise and describe technology-enabled emergent studio pedagogies. In more detail, the observed technologies in this thesis are those of augmented reality visualisations embedded into design critique sessions, and the use of Wikis for online communication throughout a studio course. The research question pursued along this thesis is, then, “**how do the use of AR visualisations and the use of supporting Wikis impact on communication in the architectural design studio?**”.

For such enquiry, it is claimed that the integration of technology into architectural education contexts does not proceed only on the grounds of tools’ development and training, but on a series of complex interrelations across technological, communicational and societal patterns that once orchestrated, provide a vehicle for such technology-driven pedagogies.

However, the observation of the architectural design studio as a social setting mediated by technologies comprises to not only conduct extensive observational work, but also to question and reflect upon how its constituent institutions (e.g. the design critique, the design jury) are potentially augmented by technology. In that sense, this research has been conducted as a “cognitive ethnography”, by taking into account both experimental and observational research procedures to unravel its communication dynamics in the context of **actual design studio settings**, as opposed to highly controlled lab-based design scenarios. As a result, a series of research methods and techniques are described to operate as a participant observer

in such settings, their practicalities and limitations, and the theory informing such methods. The main contribution of this approach is the collection, transcription and analysis of on-site gathered data, therefore grounding the research results to the contexts in which they operate - supporting the validity and applicability of the research outcomes.

The resulting theory outputs - namely “**theory of augmented pedagogies**” - describes the emergent communication dynamics resulting from the use of such tools. Its construction process is as follows:

After observational data is analysed following an incremental coding process, a set of conceptual categories (**a set of conceptual categories**) is created, and then linked to each other allowing the formulation of a framework. The framework, composed by seven categories, clusters systematically built evidence of the complex role of technology for architectural education purposes. The categories are: **solo interactions, social interactions, technology affordances, troubleshooting, emotional engagement, multimodal engagement, and organisational shifts**. Those categories are organised in two core topics that describe the impact of technologies in the architectural design studio: “augmented interactions” and “pedagogical implementations of technology”. Throughout the definition and scope of those topics, various links across pedagogy and technology are claimed.

The outcomes of this research intend to serve as a pedagogical resource for integrating new technologies into architectural design studios, and organise those newly emergent pedagogies as novel educational resources. Since it is based on a grounded theory approach, the framework is also flexible enough to accommodate further pedagogical knowledge, and paths for future work are identified accordingly.

It is concluded that amid diverse views and approaches towards architectural education, instructors mainly operate with little supporting pedagogical resources and mostly following an experience-based teaching approach. As such, new ways to organise and transfer pedagogical knowledge in relation to technology-enhanced learning, such as the one derived from this work, are a contribution to the work of architectural educators. On a secondary claim, it is asserted that the outcomes of this work also contribute towards the development of technology for educational purposes.

LIST OF CONTENTS

Acknowledgements	iv
Abstract	vi
List of Contents	viii
List of Figures and Tables	xiii

CHAPTER I. Introduction _____ 1

- 1.1. Investigating the impact of technology in architectural education
 - 1.1.1. Classifications of the roles of technology for architectural education
 - 1.1.2. Augmenting reality and using Wikis
 - 1.1.3. Characterising the design studio as a communication space
- 1.2. Research problem
- 1.3. Research question
- 1.4. Research objectives
- 1.5. Research outputs and relevance
 - 1.5.1. Theoretical outputs
 - 1.5.2. Methodological outputs
 - 1.5.3. Target groups
- 1.6. Methodology
- 1.7. Dissertation structure

CHAPTER II. Setting a disciplinary framework to observe communication in architectural design studios _____ 17

- 2.1. Introduction
 - 2.1.1. Situating human communication into a disciplinary landscape
 - 2.1.2. Structure of the Chapter
- 2.2. Architectural education - reconsidering educational practices
 - 2.2.1. Theorising the design studio
- 2.3. A multimodal approach to investigate architectural design studio dynamics
 - 2.3.1. Investigating communication as a “cognitive ethnography”
 - 2.3.2. Multimodality as a research approach
- 2.4. Multimodality in design research
- 2.5. Tracing multimodality in the use of Wikis
- 2.6. Summary and conclusions

CHAPTER III. Research fieldwork: contexts and methods in design studio settings _____ 45

- 3.1. Introduction

- 3.1.1. Structure of the Chapter
- 3.2. Participant observations in design studios
 - 3.2.1. Site selections
- 3.3. Preliminary study: technical affordances and challenges of augmented reality models
 - 3.3.1. Lessons for data collection
- 3.4. Methods to investigate face-to-face interactions in design critique sessions
 - 3.4.1. Video-recording design critique sessions
 - 3.4.2. Students' semi-structured interviews
- 3.5. Investigating students' collaborative work using Wikis
 - 3.5.1. Observing communication in on-line environments
 - 3.5.2. Collection of Wiki sites' modes of communication
 - 3.5.3. Students' semi-structured interviews
- 3.6. Investigating instructors' perspectives
 - 3.6.1. Instructors' semi-structured interviews
 - 3.6.2. Participant observations
- 3.7. Recommendations and reflections for data collection in the design studio
 - 3.7.1. The observer/instructor dichotomy
 - 3.7.2. Transcribing multimodal face-to-face communication
 - 3.7.3. Transcribing multimodal on-line communication using Wikis
- 3.8. Summary and conclusions

CHAPTER IV. Construction of conceptual categories: analysis of face-to-face interactions during design critique sessions _____ 73

- 4.1. Introduction
 - 4.1.1. The communication dynamics of a design critique session
 - 4.1.2. Design critiques' selection for data analysis
 - 4.1.3. Face-to-face multimodal interaction: exemplary dialogues across participants
- 4.2. Conceptual derivation: naming and coding incidents through comparative analysis
 - 4.2.1. A multimodal description of relevant incidents
 - 4.2.2. Naming and coding relevant incidents
- 4.3. Defining sets of relevant themes
 - 4.3.1. Solo interactions
 - 4.3.2. Social interactions
 - 4.3.3. Technology affordances
 - 4.3.4. Troubleshooting
 - 4.3.5. Multimodal engagement
 - 4.3.6. Emotional engagement
 - 4.3.7. Organisational shifts
- 4.4. Findings of the descriptions of face-to-face interactions using AR models
 - 4.4.1. Conceptual integration
 - 4.4.2. Augmented interactions
 - 4.4.3. Pedagogic implementations of technology
- 4.5. Summary and conclusions

CHAPTER V. Building frameworks: Analysis of students' collaborative work using Wikis _____ **99**

- 5.1. Introduction
 - 5.1.1. Structure of the Chapter
- 5.2. General features of the use of Wikis for design education
- 5.3. Depicting students' multimodal communication using Wikis
 - 5.3.1. Design and construction of the Wiki sites
 - 5.3.2. Group interactions in the Wiki sites
 - 5.3.3. Studio interactions in the Wiki sites
- 5.4. Building frameworks: revisiting and structuring conceptual categories
 - 5.4.1. Evolution of the conceptual vocabulary into emergent pedagogical frameworks
- 5.5. Discussion and conclusions
 - 5.5.1. Instructional and curatorial modes of communication using Wikis
 - 5.5.2. Methodological considerations
 - 5.5.3. Summary and conclusions

CHAPTER VI. Validation, conclusions and recommendations for further work _____ **123**

- 6.1. Introduction
- 6.2. Main findings
- 6.3. Validation
 - 6.3.1. Setting instances for the theory framework
 - 6.3.2. Characterising the interviewees
 - 6.3.3. Content analysis of responses
- 6.4. Applicability of the framework
- 6.5. Main contributions of the research
 - 6.5.1. General contribution to architectural design education
 - 6.5.2. General contribution to design research
- 6.6. Recommendations for further work

List of References _____ **139**

List of Appendices

- Appendix I.** Veliz, A. (2013). Augmented modelling in the design studio: Augmented pedagogies. *Augmented reality, art and technology*, 3, 58-63.
- Appendix II.** Transcripts of design critique dialogues making use of AR technology, and detail of coded incidents isolated from the data transcripts.
- Appendix III.** Sample transcript of fieldwork observational notes at the Polytechnic of Turin.
- Appendix IV.** Sample Wiki screenshots
- Appendix V.** Ethical considerations in design studio fieldwork
- Appendix VI.** Interviews questionnaire

LIST OF FIGURES AND TABLES

FIGURES

- Figure 1.1.** AR model that combines into a single visualisation a physically printed floorplan and a digital 3D model. The model is built using the tool metaioCreator 2.0. _____ 6
- Figure 2.1.** A complex assembly of representations made by a group of students being used to communicate a final project in a MArch course at the Liverpool School of Architecture. _____ 28
- Figure 2.2.** Video screenshot - A student describes to the design instructor an architectural model that combines a physically printed floorplan with a 3D model of the building's form, by using AR technology. _____ 30
- Figure 2.3.** Donald Schön's "The Reflective Practitioner" (1983) with drawings to illustrate the dialogue between "Quist" and "Petra". Pages 82, 83, 86 and 87 are here reproduced with permission from Perseus Book Group. _____ 35
- Figure 2.4.** Screenshot of the Wiki site developed by group 5. Source: designpedagogy.org. _____ 41
- Figure 3.1.** Summary of selected research methods utilised in the different stages of this research. _____ 53
- Figure 3.2.** Sample models developed by students. Left: Augmented model to study the layout of an exhibition space. Right: A furniture layout model. _____ 54
- Figure 3.3.** AR-supported distance measuring functions. _____ 54
- Figure 3.4.** Sample video frames of participants interacting with AR models. _____ 57
- Figure 3.5.** Sample Wiki site screenshot (Group 2). From left to right: a description of a building detail and materials, cutting patterns of the elements of the pavillion, renders of the finished pavillion. Source: University of Liverpool Blackboard system (2014). _____ 60
- Figure 3.6.** Wiki site screenshots (Group 1). Top image: Record of the e-mail communications across members of the group. Bottom image: Scanned record of the group sketching meetings. Source: University of Liverpool Blackboard system (2014). _____ 61
- Figure 3.7.** Schedule displaying the time/day of different comments made in the Wiki sites throughout the semester. The studio teaching time

is highlighted in yellow, instructors' comments in red and students' comments in blue. Source: Kocaturk et al, 2014. _____	62
Figure 3.8. Identification of the roles of texts and images within the layout of a Wiki site. Source: University of Liverpool Blackboard system (2014). _____	63
Figure 3.9. Array of representation and communication tools declared to be used by students throughout their design process. Source: Kocaturk et al, 2014. _____	64
Figure 3.10. Sample data transcription sheet. _____	70
Figure 3.11. Extract of a communication Wiki site (Group 1). Source: University of Liverpool Blackboard system (2014). _____	71
Figure 4.1. Video frames illustrating the different instructors' roles uses of an AR model during a design critique session. _____	79
Figure 4.2. Video frames relevant to describe the interaction between a group of students and instructor, sequenced indicated in the text (a, b, c, d). _____	82
Figure 4.3. Hand coding of transcribed data sheets. _____	85
Figure 4.4. Video frames that show some interactions between people by using augmented models. Most of the actions in this category involve the use of AR on screen (for visualisation purposes) or pointing at it as a communication resource. _____	88
Figure 4.5. Video frame showing the misaligned AR model. The arrow at the bottom indicates the location of the marker on the top of the floor plan, while the arrow at the top of the screen indicates the actual location of the digital model. _____	90
Figure 4.6. Gestural performance from Alberto indicating some cognitive engagement with the construction of AR models. _____	91
Figure 4.7. Gestural performance from a student indicating some cognitive engagement with the construction of AR models. _____	92
Figure 4.8. Initial grouping of conceptual categories into core topics. _____	95
Figure 5.1. Sample Wiki site. Contents are here organised in columns. Source: University of Liverpool Blackboard system (2014). _____	105
Figure 5.2. Sample Wiki site. Source: University of Liverpool Blackboard system (2014). _____	107
Figure 5.3. Sample collaboratively-built sketches. Source: University of	

Liverpool Blackboard system (2014). _____	110
Figure 5.4. Different representations utilised by groups of students to display their design work, including (from left to right, top to bottom): meetings minutes, sketches, parametric modelling sequences, mindmaps, drawings, sun shading analyses, fabrication patterns, 3D models, and renders. Source: Kocaturk et al, 2013. _____	111
Figure 5.5. Sample Wiki site. Source: University of Liverpool Blackboard system (2014). _____	112
Figure 5.6. Perceived benefits of using Wikis throughout the studio course. Source: Kocaturk et al. (2014). _____	115
Figure 6.1. Diagram of the applicability of the framework to Ian’s teaching approach. _____	133
Figure 6.2. Diagram of the applicability of the framework to Noel’s (red), Barry’s (green) and Andy’s (blue) teaching approaches. _____	134

TABLES

Table 1.1. Categories of the use of technologies for architectural education, as stated by Andia (2002) and Mizban & Roberts (2008). Highlighted in red are the categories considered as relevant for this research. _____	4
Table 3.1. Table indicating the transcription notations used in data transcriptions. _____	69

CHAPTER I

INTRODUCTION

1.1. INVESTIGATING THE IMPACT OF TECHNOLOGY IN ARCHITECTURAL EDUCATION

The core locus of architectural education is the design studio¹. The studio is a project-based learning system, in which students continuously interact with tools, methods, instructors and peers throughout the development and resolution of a given design brief. Those interactions are usually structured into a series of rather traditional institutions such as design critiques or the design jury sessions. There is a series of factors influencing the studio pedagogy such as the nature of the design briefs, or the design tools, skills and methods considered relevant by the instructors. Such array of interrelated elements render the studio into a teaching and learning environment bridled with complexities, yet with a proven effectiveness on educating architects for several decades (Cuff, 1991) and moreover, it has been suggested as a good practice for other Higher Education professional subjects (Boyer & Mitgang, 1996).

Nowadays, the fact that technologies are reshaping architectural education is widely accepted in our discipline, and technology literacies have been acknowledged as part of the skillset of future architects (Andia, 2002; Building Futures, 2013). New demands from an increasingly collaborative industry as well as global issues are adding requests for technology integration in the education of contemporary architects. Among other requirements for the new architects, it has been reported that they require higher levels of ICT literacy, technology-enabled representation skills and mastery of collaborative working schemes and tools (Building Futures, 2013).

In the United Kingdom, this array of requirements has been usually framed within the Graduate Attributes for Part 1 (undergraduate) and Part 2 (postgraduate) Architecture validated courses (RIBA, 2014). Those attributes have been defined as “the ability to apply a range of communication methods and media to present design proposals clearly and effectively” (namely “GA1.2” for Part 1 courses), and the “ability to evaluate and apply a comprehensive range of visual, oral and written media to test, analyse, critically appraise and explain design proposals” (namely “GA2.2” for Part 2 courses). Therefore, digital

¹ Throughout this dissertation the term “design” is referred to “architectural design”. Likewise, “studio” and “design studio” are referred to the architectural design studio.

communication skills and contents are part of the validation process for every School of Architecture in the country.

However, the integration of technologies in the design studio has been accompanied by its implications for teaching and learning. In that regard, this research works towards a better comprehension of how technologies impact the design studio. More specifically, it aims to understand how visualisation (augmented reality) and communication (Wikis) technologies can contribute to enhance teaching and learning in architectural education. Here, the ways in which educational dynamics are reorganised are explored; how those emergent didactics can be formalised into technology-driven pedagogical resources; and how the identification of such pedagogies can benefit the studio community are explored.

1.1.1. Classifications of the roles of technology for architectural education

Previous research (Andia, 2002; Mizban & Roberts, 2008) has classified different roles of technologies for teaching and learning in architectural education (Table 1.1). Both studies have been conducted in design studios, doing either observational ethnographic work (in the case of Andia) or a mixed-methods qualitative methodology (in the case of Mizban & Roberts, including revisions of literature and interviews with informants). Additionally, both studies have been conducted in different contexts: Schools of Architecture in the USA and Japan (Andia, 2002) and British Schools of Architecture accompanied by other examples from the literature (Mizban & Roberts, 2008). Despite the different contexts for their enquiry and methodological approaches, however, their work coincide on some core matters such as the need to broadly understand learning technologies as facilitators of an educational experience, beyond its use for novel and complex emergent design products and processes.

Aligned with their viewpoint, this research sees technologies as enablers of an augmented educational experience, by mediating **design communication** across members of the studio during teaching and learning activities. This view coincides with the categories already presented in previous research, such as the “Virtual Studios” proposed by Andia (2002), which he partially describes as

All of these experiences are slowly but consistently broadening the design

studio experience by introducing external reviewers and a more collaborative environment among students, professors, and consultants. This new mode of collaboration increases the transmission of ideas and could open the congested culture of traditional design studios (p. 11).

Table 1.1. Categories of the use of technologies for architectural education, as stated by Andia (2002) and Mizban & Roberts (2008). Highlighted in red are the categories considered as relevant for this research.

The effects of computers in architectural education (Andia, 2002)	Implementation of e-learning in architectural design education (Mizban & Roberts, 2008)
Design methods	Professional communication tools (e.g. videoconferencing)
CAD visualisation	Virtual studios (e.g. discussion boards, weblogs) ²
Paperless architecture	Shared repositories and databases
Information architecture	Software written to help students reflect upon their design (e.g. environmental performance)
Virtual studios	Software written to help students with particular concepts (e.g. principles of structural design)
	Virtual reality and 3D CAD
	Web pages (i.e. where students can display and share their design project work)

² Given its relevance for this research, it is important to stress the difference between the definitions of “Virtual Studios” in both studies. As mentioned, Andia’s interpretation (2002) focuses on the resulting collaborative studio environments through the use of ICT resources, pointing out the potential of technology for the “transmission of ideas” in the “congested culture” of design studios (p. 11). This approach diverges from Mizban & Robert’s work (2008), that defines Virtual Studios following the typically found (e.g. Kvan, 2001) definition of an experimental, remote, and web-based collaborative studio, usually with an international component. In that sense, remote collaboration between institutions is outside the scope of this work and therefore Andia’s definition (2002) has been considered as appropriate and closer to what Mizban & Roberts (2008) define as “Web pages”. A further discussion on how incidents and categories are named in theoretical research is presented in **Chapter IV**.

This distinction between “technologies for design” and “technologies for teaching and learning” is rather relevant considering that technologies provide tools and methods embedded into intelligently networked contexts and processes of design knowledge production and communication. Their use blurs and mixes the boundaries across different processes of students’ work, including those of “designing” and “learning”. Then, it must be noted that while this work is particularly concerned with technology-mediated learning, the explored technologies broadly operate as a coordinated ecology of socio-technical systems by influencing the studio’s mutually interdependent working environments and social dynamics (Heller, 2001). As already stated, the technologies that this research focuses on have a role on design communication in the design studio, making use of a set of various modes of communication such as images, speech or text. In more detail, the technologies utilised to explore those “augmented pedagogies” in this research are two: **augmented reality (AR) visualisations for design critique sessions** (related to what Mizban & Roberts define as “Virtual Reality” and “3D CAD”), and the use of **Wikis for on-line supported communication** (related to what the same authors define as “Web pages”) throughout design studio courses.

As seen in the next section, those tools enable a deeper, yet not full, understanding of the impact of ICT resources for teaching and learning in the design studio.

1.1.2. Augmenting reality and using Wikis

The rationale to choose AR and the use of Wikis as the pathway through which studio pedagogy evolves, responds to the need to observe different dimensions and dynamics of communication in studio teaching and learning.

Firstly, AR provides a resource to merge both physical and digital representations into single visualisations, and therefore providing students with a novel way to communicate the geometry of their design intents (Figure 1.1). Such feature has been utilised in various applications (visualisation, construction management, simulation, among others) at different stages of the design-to-construction process, as has been well documented in the literature in the form of novel written software and lab trials. Some relevant and illustrative cases of AR

applications in the AEC industry have been developed by the “Augmented reality and 3D tracking” group at VTT Finland, and the Australasian Joint Research Centre in BIM at Curtin University in Australia. These applications are usually aligned with industrial developments and products that make use of augmented reality tools, such as augmented reality gaming engines and head mounted displays. Overall, AR is a quickly developing field as can be seen in the academic repositories, technology events and ongoing commercial applications from organisations such as SIGGRAPH, Ars Electronica and Microsoft.

For the purpose of this research, small-scale applications have been utilised in design studios, making use of freely available software for the construction of reduced and easily viewable architectural models. This specific application, called marker tracking, works by recognising a figure (namely “the marker”) using a camera and a tracking engine, and displaying a geometric model accordingly, following the marker in real-time as it moves in the space in front of the camera.

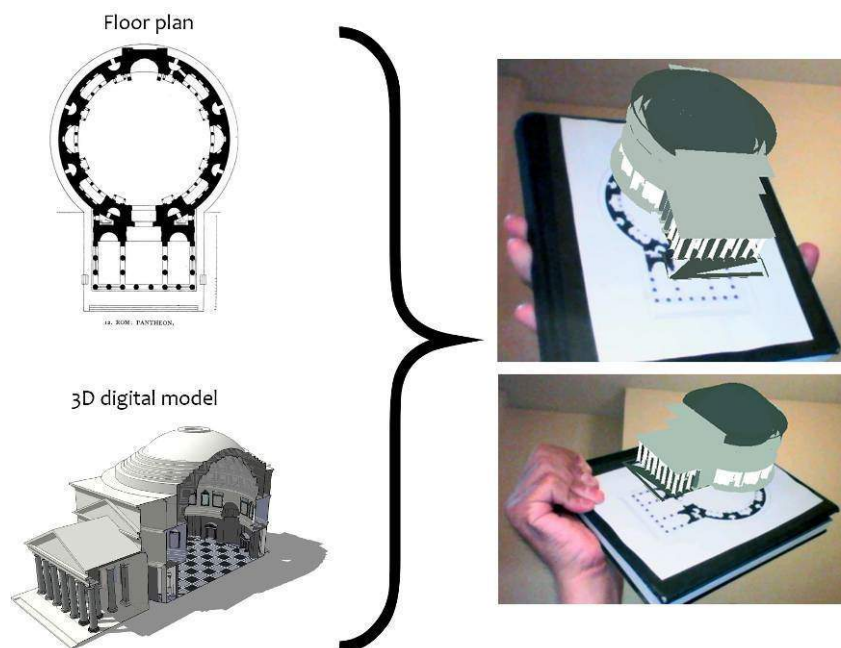


Figure 1.1. AR model that combines into a single visualisation a physically printed floorplan and a digital 3D model. The model is built using the tool metaioCreator 2.0.

Wikis, on the other hand, are here observed as a communication tool to support students’ collaborative work. Wikis are “a set of linked web pages (and

the application enabling its development), created through the incremental development by a group of collaborating users” (Wagner, 2004). For the purpose of this research, a group of MA Architecture students at the University of Liverpool have used Wikis to keep a record of their design processes, allowing the use of on-line conversation forums and the display of a series of images - as a sort of digital sketchbook updated at any time, with continuous feedback from peers and instructors. In that sense, Wikis contribute to this research by allowing the observation of students’ communication outside teaching hours and as a result, allowing a more comprehensive monitoring of student’s working and communicating dynamics.

As a result, a wide scope of studio teaching and learning is achieved by observing both technologies, but it must be noted that other elements of design studio teaching such as design reviews are out of the scope of this work. This is aligned with the characterisation of the design studio as a learning activity across ubiquitous locations and temporal frames, as well as with an updated understanding of how students visualise and communicate design knowledge and information through different media.

In that sense, the name of this research (“augmented pedagogies”) has not been chosen only after the observation of AR tools in design, but is more broadly aligned with the concept of “augmentation” developed by Buechner (2011) who describes it as an “action of enhancement or improvement” of reality. In his words, he describes how augmented reality can actually support the performance of cognitive activities:

One kind of augmented reality (...) is a virtual modification in which various features of reality are virtually enhanced (...). Suppose virtual non-existent beings are added to one’s visual field. If they talk, move, touch, and so on, those features will be features of the total experiential field that constitutes one’s reality. More importantly, if they provide information to a user by speaking, the user will be able to employ that information in performing various cognitive activities (...)

1.1.3. Characterising the design studio as a communication space

Among the core tasks making use of technologies in the design studio, is that of **modelling**. The visualisation and communication of models are the main resources students' utilise to display their design work, request feedback or are assessed. Design instructors, on the other hand, make use of models as teaching resources, and as evidence of skills and mastery of design techniques by the students.

Throughout a studio course, the use of representations is the main method by which ideas are expressed in order to 'move across' different design solutions as the design process proceeds (Goldschmidt, 1997). It should be acknowledged, however, that if architectural models "speak" or "talk back" to the designer is an ongoing disciplinary polemic in design research. For some authors models do not "talk back" and are the external representation of internal ideas and thoughts (e.g. Goldschmidt, 1997). In educational contexts, however, architectural modelling can be framed within Kolb's learning cycle (Kolb, 1984) as part of the processes of "active experimentation" or "concrete experience", which can actually lead to further stages of the learning cycle and therefore "talking back" by enabling further cognitive processes. Those "design moves" affect the way in which design information is shared and engage the designers into a continuous feedback between mental images and representations (Brown, 2003). Relevantly and as will be furtherly described, this view of models as tools for learning and further inquiry has been already theorised by Schon (1983) as part of his "reflection in action" description of design learning.

Given such flows of design communication through models, an investigation of the ways in which the participants of the design studio interact using models can be framed within the domain of social semiotics. Semiotics is a branch of communication research that accounts for the way in which meaning is constructed, and by doing so contributes to the understanding of the interpretation of design models and how they embody and convey design information and knowledge. Additionally, on a more recent development in linguistics and communication research (Hodge & Kress, 1988), **social semiotics** investigates the way those meanings are constructed and conveyed within social settings, thus turning this stance as appropriate to observe design studio settings.

This research standpoint is supported by concurrent and contemporary research in social semiotics (Hodge & Kress, 1988; Kress, 2010; Jewitt, 2009). Following the work of Hodge & Kress (1988), **multimodality** accounts for the observation of coordinated multiple modes of communication as the embodiment of socially constructed meanings (Kress, 2001; Jewitt, 2013). This approach addresses communication as a mean to understand the construction of texts and meaning by defining and describing such intelligent orchestrations across different modes of communication, such as spoken dialogues, gestural communication, gaze, and so on.

This research, then, characterises the studio as a series of learning situations in which people interact in several, yet intelligently interrelated ways; design studio education is here described as a set of activities across different settings and diverse modes of communication. Such fabric of socially constructed patterns comprise not only formal studio teaching time, but also students' ubiquitous work outside teaching hours, in various locations and times.

1.2. RESEARCH PROBLEM

As already reviewed, the integration of digital tools into design education does not entail only emergent design processes and products, but also reaches and impacts upon a networked series of dimensions of the educational experience (e.g. design brief, mastery of skills, professional values, among others). In that sense, this research observes technologies and their dynamic and situated role across different collaborative, organisational, emotional and cultural dimensions of teaching and learning architectural design. It is not clear, however, how these impacts occurs, and there is limited evidence on how ICT tools have been used to support specific pedagogic needs in architectural education (Mizban & Roberts, 2008).

The lack of a formal theory that defines how technology re-shapes communication in the design studio results in very limited knowledge reusability and in turn, into very caged and localised pedagogical frameworks that do not allow cross-institutional or cross-disciplinary collaboration, to evaluate the constant integration and evolution of new learning technologies or to reuse a pedagogical approach and its associated knowledge. As such, the problem this research tackles the void in knowledge created by the scarce formalisations of the

impacts of technologies in the contemporary architectural design studio.

1.3. RESEARCH QUESTION

Following the exploratory nature of this work, several questions arise and hypotheses are proposed as the research proceeds. However, the thread upon which this work is structured answer to the following:

- **How do the use of AR visualisations and the use of Wikis impact on communication in architectural design studio courses?**

Throughout the development of this research, it has been considered the quick pace at which visualisation tools and on-line environments are being developed. I do not pursue, then, the construction of a fixed theoretical framework, but instead a flexible, systematically built **theory of augmented pedagogies** that can furtherly accommodate technology developments and emergent studio teaching and learning modes. In this sense, it is not expected a definitive, one-size-fits-all set of results but instead a set of theory outcomes applicable in the observed contexts of design pedagogy.

Throughout the research process, an extensive range of multidisciplinary sources are utilised such as technology-enhanced learning, computer supported collaborative work, multimodal communication and visual analysis, social semiotics and educational research. Additionally, this work is fed by my own interpretations as a participant observer in the investigated settings, and my experience of 8 years involved in architectural education in various contexts and roles. This has served as an interpretative tool, allowing me to understand the codes and practices of the design studio, more easily approach informants and arrange technology induction sessions prior to data collection stages.

Such approaches to research are aligned with the current need to formalise pedagogical knowledge from a range of perspectives and domains which do not only minimise my own bias throughout the analyses, but also counteracts the tendency of reaching false or incomplete results (Eisendhardt, 1989) whilst providing a complete account of the observed phenomena. Therefore, a set of research methods and data sources are utilised in different sections, and their strategic role within the research process is appropriately described when required.

1.4. RESEARCH OBJECTIVES

The theory of augmented pedagogies is yet to be determined by the demand to depict and formalise pedagogical knowledge derived from technology-mediated communication in the contemporary design studio. In order to achieve this goal, the objectives of this work are:

1. **To situate architectural design pedagogy in the context of communication studies,**
2. **To develop a multimodal research approach and its corresponding methods and tools for architectural education research, and**
3. **To construct a series of descriptive interrelated concepts, and a subsequent theory framework.**

1.5. RESEARCH OUTPUTS AND RELEVANCE

1.5.1. Theoretical outputs

March & Smith (1995) have defined theoretical outputs in technology research as a series of constructs, models, methods or instantiations. Following this precept, the outputs of this research incrementally produce the building blocks of a “theory of augmented pedagogies” as the dissertation proceeds.

The initial output of this work consists of an assembly of interrelated **conceptual descriptions (categories)** describing the impact of AR and on-line communication technologies. A set of relationships across these constructs allows the development of **pedagogical frameworks (a model)** that classifies and organises this knowledge. Finally, the validity of the theory of augmented pedagogies is here explored by enquiring design instructors’ practices within the design studio, their approaches towards learning technologies and their diverse views on students’ learning. This knowledge results on a series of **situated contexts of teaching and learning (instances)** in which the theory can be tested, thus depicting an understanding of the limits of this contribution to knowledge.

1.5.2. Methodological outputs

Various experimental settings and data sources are utilised in this research.

Despite the fact that design studios differ in their approach to design problems, students' background and institutional standpoint towards design education, every case is aligned with the tendency of the occidental world in architectural education (Cuff, 1991), that is a project-based course in which the core knowledge transfer activity is the design critique (Webster, 2008). Consequently, it is anticipated that the theory framework has a potentially broad scope of generality and applicability. The operational knowledge elicited from this fieldwork has, additionally, produced as a secondary output **a set of interrelated research methods** to understand multimodal communication in design studios.

1.5.3. Target groups

As Breen (2002) points out, research in architectural design education is closely related to the domains of architectural design theory and architectural design practice by being primarily targeted at the production of knowledge, insights and skills. This extensive nature of architectural research requires clear descriptions of the main target groups towards which this research is aimed at. Two target groups are expected to benefit from this research. Primarily, the architectural design education community (instructors and students) will benefit from the production of theory outputs that account for the use of AR and Wikis for teaching and learning purposes. Secondly, technology developers will benefit from these outputs, which are elicited from the observation of the use of AR visualisation tools and on-line educational environments.

1.6. METHODOLOGY

While a strong stream of research and literature has been devoted to the methods and suggestions for educational research in generic educational contexts (lecturing environments and primary education, for instance), the research work reporting complex higher education environments for professional education such as design studios is scarce (Schon, 1983; Boyer & Mitgang, 1996). This is yet an important challenge for further research in architectural education, given that the design studio is its “signature pedagogy” (Schulman, 2005), which defines to a great extent the process of induction of novice designers into the practice of the profession (Cuff, 1991).

The design studio system has been, nevertheless, largely observed and suggested

as an exemplary teaching practice for other fields, with several authors encouraging academics from other disciplines to adopt such type of project-based scheme. For instance, studio-like project based learning has been considered of value for sciences education (Schon, 1988). The Boyer-Mitgang Report (1996) describes the design studio as a powerful method of education, and suggests to find wider applications in other higher education contexts. As a result, there seems to be an apparent conflict between a largely acknowledged teaching and learning system, but yet limited accounts of how educational research is conducted and how the interactions that shape teaching and learning take place within it.

In that sense, there is no standard or single good-practice recommended methodology to observe technology-enhanced learning in architectural education. Conversely, each study requires a unique standpoint in terms of validity and fitness to the research problem and the subject matter. As Orlikowski & Iacono (2001) state, this corresponds to the fact that the use of technologies highly relies on the application context and, therefore,

there is no single, one-size-fits-all conceptualization of technology that will work for all studies (...) researchers need to develop the theoretical apparatus that is appropriate for their particular types of investigations, relying on their questions, focus, methodology, and units of analysis (p. 131).

Given the aim of this work and the limited amount of related previous research, the use of an exploratory methodology focused on the generation of theory fits with the context in which technologies are observed and analysed. The process of gathering data, data analysis and outputs generation follows a **grounded theory methodology** (Glaser and Strauss, 1967; Strauss and Corbin, 1990; Charmaz, 2006; Bowen, 2006).

Grounded theory emerged in the first place as a mean to bridge the gap between the development of a theory in the social sciences and the actual, real-world situations in which that theory operates (Glaser and Strauss, 1967). In that sense, the developers of grounded theory state that the construction of a theory directly from its context of operation involves strong links between the data and its context, a deep analytical understanding of the observed social setting, and therefore inherently assuring the applicability and generality of results.

In order to provide a structure to the theory development process, the action of ‘coding’ is the one in which data is processed by scaling from basic themes and identification of concepts (open coding) up to emergent patterns, topics and dimensions in which the theory outputs are integrated and refined (selective coding), so that the core topics emerge. Conclusions are therefore obtained in relation with the data during the research process in which the theoretical results will be grounded, rather than in a separated final stage. This is reflected on the way this dissertation is structured.

1.7. DISSERTATION STRUCTURE

This dissertation is structured into 6 chapters. After this Introduction, Chapters 2 and 3 are dedicated to the construction of a research space by proposing a disciplinary framework for this work, and a set of methods and techniques to operate within such framework. Throughout Chapter 2, I discuss and analyse related disciplines and previously conducted research to set a path towards the observation of technology-mediated communication in the architectural design studio through a literature review. After describing how processes such as learning have been observed in the past, I then narrow the discussion down to the previous observations of communication patterns in social settings. I then situate that discussion into related research conducted in architectural design practice and education, by observing previous works that have described design as interaction, such as the reflection-in-action theory by Donald Schon (1983), the uses of protocol analyses to describe design activities (Cross, 2011) or more recent work in alternative modes of communication, such as Mewburn’s research on gestural communication in design studio settings (2009) and on-line interactions in educational settings (e.g. Mayer, 2008). As a result, a foundational disciplinary ground is laid to both trace a continuity between this research and its precedents, and to additionally elicit the relevant modes of interaction in design which have been historically observed.

Once the disciplinary framework is set, Chapter 3 is devoted to the series of research methods and techniques that allow me to operate within such given framework. This series of methods are close to observational research methods, given my direct involvement as a participant observer in the research settings. Chapter 3 describes how different interrelated research methods facilitate the

different stages of this research, their practicalities and limitations, and the theory informing such methods.

Then, the construction of the theoretical outputs of this research is presented. Chapter 4 begins by exemplifying how different modes of communication are involved in an “architectural dialogue”. Data obtained after design critique sessions were conducted with the mediation of AR tools is here presented and described. By reviewing, coding, and patterning data from those interactions, early conceptual definitions are built in order to ground a conceptual vocabulary accounting for that social setting.

Chapter 5 expands this theory construction process by exploring students’ communication in on-line environments. Here the observed social setting is that of students’ on-line collaborative work using Wikis, and data is obtained by reviewing and analysing the modes of communication and their assemblies within such communication dynamics. The core argument of this chapter is that online collaboration poses different modes of interaction allowing the observation of informal learning - a scarcely observed dimension of architectural education (e.g. Knight & Brown, 2010).

Finally, Chapter 6 discusses the validity of the findings, summarises the theory outputs of this research and concludes this dissertation. A discussion of validation is presented by analysing in-depth interviews with design studio instructors from the University of Liverpool. Those interviews illustrate the needs and diverse views of design instructors in terms of technology-enhanced learning, their own construction of pedagogical frameworks, and their limited - yet effective - use of pedagogical resources. Additionally, contents and outputs from previous Chapters are recalled in order to fully present the theory’s disciplinary scope, and its constituent elements (a conceptual vocabulary, and a pedagogical framework). Then the Chapter draws upon the conclusions and recommendations for further work. Here the compliance between the obtained outputs and the objectives of this work are described, as well as the contributions to design research, to architectural education research, and to the development of visualisation and on-line communication technologies for teaching and learning.

CHAPTER II

**SETTING A DISCIPLINARY
FRAMEWORK TO OBSERVE
COMMUNICATION IN
ARCHITECTURAL DESIGN
STUDIOS**

2.1. INTRODUCTION

The outcomes of this Chapter are twofold. Firstly, it sets a disciplinary context in which this work is situated, by critically discussing existing streams of research and their approaches to the observation of communication in architectural design education and practice. Different experiences in architectural education are here presented as a mean to encompass a broad understanding of communication within a multidisciplinary framework.

Secondly, it will systematically review the different utilised ways in which communication in architectural education and practice has been observed, by identifying the typically observed modes of communication in concurrent research. For such purpose, the Chapter introduces the concept of multimodality as a mean to identify, observe, record and analyse different yet interrelated modes of communication. This information will later provide the groundwork to the construction of a methodological apparatus to operate within this disciplinary framework, in **Chapter III**.

2.1.1. Situating architectural communication into a disciplinary landscape

Throughout the last decades, technology developments have allowed the emergence of novel information and communication resources that enable new forms of approaching, producing, testing or disseminating design knowledge. The more specific observation of communication dynamics in architectural education and practice has been historically, however, related to the field of psychology (e.g. Oschner, 2000). Given its inherent psychological nature, communication phenomena have been observed from various perspectives within the psychological sciences: cognitive studies, behavioural studies, and psychoanalysis among others. Those perspectives have been coincidentally followed by different design researchers to situate the observation of design communication into specific disciplinary frames, such as the psychoanalytical description of the design studio interactions by Ochsner (2000) or the protocol analysis approach (Purcell and Gero, 1998), which highly relies on the observation of behaviour.

Novel theories are nowadays finding ways to integrate the understanding of

communication as a distributed process across internal, observable and socio-technical dimensions of human psychology. Early examples of these steps were the formulation of critical, discursive and post-modern psychology.

Another recent example of the attempts to reach an understanding of technology in social settings is the theory of distributed cognition (Hutchins et al, 1986) - which additionally includes components related to cultural anthropology and sociology. The theory of distributed cognition observes human cognition as a flowing and situated assembly across internal and external representations, thus keeping focus on both the machinery of “private behaviour” (as described by early cognitivists) as well as the socio-technical and tool-mediated contexts in which that machinery operates (as claimed by early behaviourists).

On an early applications of distributed cognition as a way to understand learning is the widespread work of Hutchins & Klausen (1995) on “Distributed Cognition on an Airplane Cockpit” in which he describes “the cockpit” as a “culturally constituted functional group” rather than a solely individual-based entity in coordinated work with machinery. Since then, distributed cognition has been acknowledged as an emerging approach to understand cognitive systems. Recent research on architectural education has also followed a distributed cognition approach. On a recent work published by Kocaturk et al (2013), a framework is presented to support a web-based teaching environment (an ecosystem), which accounts for architectural education as a situated, tool-mediated and socially-shaped activity. As authors describe it, the proposed so-called ecosystem

is described as a community of users together viewed as a system of interacting and in(ter)dependent relationships. What we are proposing is not a substitute to the new modes of architectural education, but an essential support and a complementary activity for building an integrated, autonomous and distributed learning experience for the learner, by combining effects *with* and effects *of* technology within the same environment (p. 61).

2.1.2. Structure of the Chapter

As already mentioned, previous works can be framed within different

approaches and disciplinary frames. In this Chapter, a framework is set by describing two core streams of research. After this introduction to the broader topic of human communication and distributed cognition, a brief discussion of communication in architectural education is presented. The argument of the section is mainly developed through a review of Donald Schon's reflection-in-action theory (1983). His work is a first and widely accepted theorisation of design studio teaching, which is coincidentally based on the observation of communication between a design instructor and a student. Schon's work has been additionally utilised as an initial descriptor of other types of professional education (e.g. counselling) and has been matched with related theories for experience-based learning, such as Kolb's inventory of learning styles (Kolb, 1985). In this research, Schon's work is revisited by discussing how he made use of different modes of interaction within a design critique session as a mean to build the reflection-in-action theory.

Then, the chapter describes a novel approach to address and observe technology-mediated social interactions in design studios, with a particular focus on the use of AR and on-line communication tools. This particular approach, namely multimodality, is defined as an analytical approach to communication studies by recording, documenting and analysing the coordination across various modes of communication in social settings (Jewitt, 2009). Its use in this research aims to depict communication dynamics within a design studio and as a result, unmasking underlying "cognitive architectures" within communication across designers. It is then claimed that multimodality supports the observation of design education as a distributed, situated and technology-mediated process. Indeed, even though the design studio can be inherently considered as an environment where multimodal communication takes place, that argument is here reinforced by introducing multimodality as an approach which has been consistently developed over the last 20 years in the field of social semiotics in order to investigate such type of settings, and with a particular focus on learning environments. Related works in architectural research that previously observed different modes of interaction in design contexts are presented.

2.2. ARCHITECTURAL EDUCATION - RECONSIDERING EDUCATIONAL PRACTICES

Nowadays the core expression of architectural education is the design studio. Despite diverging contents, modules and teaching methods, the studio remains as the backbone of the architectural curricula in most Architecture programmes around the world (Cuff, 1991). The studio is usually a project-based course where students engage in design work with the support of more experienced instructors and peers. Activities such as the design brief, the critiques or the design jury sessions can be considered as typical and are deeply rooted into the studio culture (Cuff, 1991), thus becoming strong and commonplace pedagogic institutions.

Design studio pedagogy was originated as a master-apprentice atelier teaching system even before Architecture was embedded into academic contexts (Mewburn, 2011). The resulting University-based construction of studio pedagogy, however, followed those highly established practices derived from the workshop system. Some of those practices such as mentoring younger architects by members of the profession, and a guild-like structure, are still prevalent on contemporary professional bodies such as RIBA in the United Kingdom.

A long time after architecture studios were fostered in Universities, it was not until the 1970s when studio pedagogy was firstly theorised by Donald Schön (1983) and his influential “reflection in action” theory (Webster, 2008). Regardless the fact that Schön’s work (1983) was partly based on an Architecture course in the United States, the studio system has steadily spread across occidental educational institutions and has been adopted by different countries (Cuff, 1991; Dutton, 1987), and as a result his theory has until today a wide degree of applicability and generality.

2.2.1. Theorising the design studio

The “reflection in action” theory (Schon, 1983), while initially focused on design studio education, has an expanded scope that incorporates other branches of professional education (i.e. counselling was also considered for observational work). However, what begun as a partial contribution towards the reflection-in-action theory in “The Reflective Practitioner” (Schön, 1983), was

then further developed in “The Design Studio” (Schön, 1985). Here, the reflection in action theory is furtherly developed by questioning the nature of professional knowledge, and proposing a new epistemology (e.g. “a professional artistry”) that describes “knowledge” and “action” as mutually constitutive elements of professional practice. In more detail, Schön’s work (1983) emphasises the dialogical nature of design education and how “reflection in action” is embedded within its feedback processes, illustrated in his work by the partial transcription of a design critique session between an instructor (Quist) and a student (Petra).

Two years after “The Design Studio” (Schön, 1985), Dutton labeled as a “hidden curriculum” (1987) the collection of tacit normative value structures that shape studio pedagogy. Those value structures do not only shape the contents being taught but also additionally, as Stevens (1995) points out, derive into a “type of person” by shaping design habits and practices in a social environment through power and cultural dynamics. Ward (1990) details how the hidden curriculum described by Dutton (1987) is “determined to maintain, rather than challenge the status quo and thus to prevent real growth and real learning” in the studio.

Also specifically addressing the reflection in action theory (Schön, 1983), a provocative publication by Till (2005) harshly criticised Schön’s analysis by focusing on his misinterpretation of the design critique session utilised as part of his theory construction process. According to Till (2005), the design critique sequence he describes is not an actual collaborative dialogue between the student and an instructor, but it seems closer to a patronising sequence to induce the student into certain praxis, rather than an account for the reflective capacity of the student. In his words

at every stage he (the instructor) exerts his authority over the mystified student, cutting into her explanations, tracing over her drawings and eventually getting her to draw his preferred solution ... her struggle is patronisingly dismissed. (Till, 2005, p. 167).

On a more severe critique to Schön’s work (1983), Helena Webster (2008) notes those interpretation flaws (as methodological errors) but additionally

points out theoretical and validity limitations on Schön's work. While a majority of the academic community tends to agree and sympathise with the notion of "reflection in action", relevant components of studio teaching are purposefully left aside from this original theory, such as informal and peer learning. The "acculturation" of students into architects (Ward, 1990; Webster, 2008) highly relies on the way they transit towards becoming members of the disciplinary community and yet, little attention has been paid to other teaching modes and contexts beyond the design critique itself. In that sense, Webster (2008) remarks that the educational praxis described by Schon (1985) is constrained to a single design critique dialogue leaving aside other cognitive, corporeal and emotional aspects of the students' education. Moreover, the authority dynamics already highlighted by previous authors are recalled by Webster (2008) as

those readers who have read the generic literature on learning and teaching or instinctively feel that tutors should avoid coercion will find Mr Quist's (the instructor) teaching manner deeply worrying (p. 69).

The need to review other cognitive or emotional aspects of design education has been highlighted by the mentioned authors, yet the available published investigation is rather scarce. It is clear, however, that studio pedagogy is not only composed of knowledge "production and delivery" practices involving face-to-face individual feedback, but also functions as a pathway towards disciplinary habits, even at risk of unattended and tacitly accepted power and authority dynamics. The current tension between the need to reconsider our educational practices whilst operating on a highly traditional indoctrination environment is summarised by Inger Mewburn (2011) as a power struggle, by stating that

the student centred approach would suggest that too much guidance, like that offered by Quist, represses students and turns them into passive consumers rather than active participants. But the student centred discourses could in turn be questioned as reinforcing an unhelpful binary view of power, positioning it as always oppressive (p. 377).

This delicate balance between a powerful instructional guidance and students-centred discourses has been also recently highlighted by McClean & Haurigan

(2013) who remark the importance of the perceived importance of authoritative tutor guidance in developing student confidence in their work. As a result, it is plausible to note that the studio dynamics go far beyond an instructional and knowledge transfer interaction across its members, but also is composed by relevant socially and culturally shaped conducts and behaviours embedded into its inherent, and yet hardly observed, academic practices.

2.3. A MULTIMODAL APPROACH TO INVESTIGATE ARCHITECTURAL DESIGN STUDIO DYNAMICS

Extrinsic factors influencing a reconsideration of studio teaching are many (e.g. global sustainability issues, population dynamics and emergent cities, new modes of professional practice, and so on), and hardly able to be covered in a single review. This work, focused on the integration of technology in the studio and its pedagogical implications, draws upon the technological context in which designers and students produce, model and communicate within the design studio. This context is commonly set by a design brief that both allow students to produce an element of design (e.g. a building) while at the same time they learn “the trade” of the professional practice.

However, it is not entirely outlined how technologies are embedded into the design studio and become “tools for design” (e.g. tools that facilitate design processes such as form-finding) or “tools for learning” (e.g. tools that facilitate learning processes such as the development of operational knowledge). In the recent report by Mizban & Roberts (2008) the term “e-learning” is used to describe the use of technologies in architectural education and particularly within design studio teaching. After an extensive review across several Schools of Architecture, the authors develop different groups of e-learning technologies that contribute to different dimensions of design and communication.

Design tools are reportedly (Mizban & Roberts, 2008) identified as specially written, such as virtual reality and 3D CAD tools, while ICT (information and communication technologies) tools are mentioned as means for professional communication, such as virtual design studios, shared repositories and databases, and web-based resources (blogs, Wikis, among others). As mentioned, this research builds upon the technologies that they have labeled as “CAD and

3D visualisation” and “Web pages”, therefore purposefully leaving aside other aspects of ICT which can be well found in architectural design studios under different categorisations.

The infusion of these types of tools, and particularly those related to CAD and 3D visualisation is, however, not new. In “The Electronic Design Studio”, the editors McCollough, Mitchell, & Purcell (1990) compiled what became a repository of pioneering experiences on computer-mediated architectural education, based on the proceedings of the CAAD Futures Conference 1989. With Chapters presented by relevant authors in the field such as Richard Coyne or George Stiny (among others), the editors explored the foundations of computers’ integration into architectural studios across the world, in both professional and educational contexts. In that sense, the work of McCollough et al. (1990) is arguably an early description of contemporary views of computer-mediated studio education.

The presented works, however limited by the technology constraints of the time, already anticipated the roles of computers in the studio and approached different digitally-derived opportunities from instrumental (e.g. Gero, 1990), organisational (e.g. Catalano, 1990) or educational perspectives (e.g. Akin, 1990). On such early publication, Akin’s work on the impact of CAD in the design studio already warned the academic community of its potential to “change” the student, the instruction, and the instructor within the design studio (Danahy, 1991). Relevantly for this work, in “The Electronic Design Studio” an early version of an AR system was presented by Purcell & Applebaum (1989) with their “Light Table”, which allowed users to physically interact with digitally retrieved materials in a table-like screen. Yet not tested in educational contexts and despite its quite premature development, this work remarks the potential use of visual infographic systems for distributed collaborative design work, as the authors state that

to provide a distributed operating environment, the videodisc control method had to change from a local control system to a network-based control system (...) As the server could respond to requests from multiple clients, and manage switching between clients, users could share the videodisc players. (p. 233).

Similar systems have been developed over time, and the technology industry has seen great progress on technical solutions improving user experience, computing capacities, novel user interfaces or increasingly specialist software. Recently, studies such as Belcher & Johnson (2008) and Hsiao & Johnson (2011) describe significant contributions to the discipline by producing advanced and seemingly useful AR applications. The first study develops an AR visualisation system involving various functionalities, such as form generation, simulation, and collaboration for architectural design, yet no user-trials have been reported and its potential impact in design remains unknown. Hsiao & Johnson (2011), on the other hand, tested an AR model-making tool with architectural design students, yet user trials were used to outline technical limitations of the system rather than on students' learning processes.

Aligned with this viewpoint is the publication from Wang et al. (2008), who state that despite the maturity of AR for industrial applications, it has had a slow transfer and adoption process within the architectural discipline. They claim that the cause for this phenomenon is the lack of understanding of the design dynamics and therefore, efforts have hardly progressed beyond production and testing phases (Wang et al., 2008).

On a similar standpoint, the use of Wikis for design education has been usually reported as a mean of communication supporting studio courses' needs, such as communication between students and instructors. On-line learning is gaining attention from the educational community, yet it is mostly focused on its capacities related to potential higher student numbers, and geographically distributed learning environments increasing the reach of certain educational programmes. In architectural design education, one of the relevant issues raised by academics in relation to the use of Wikis and related ICT tools is the need to reconcile those different modes of delivery (Knight & Brown, 2010) with the traditional face-to-face modes of teaching and learning in design. Additionally, Knight & Brown (2010) reported the institutional agendas demanding the use of on-line support within the higher education spectrum, considering the need for increasing student numbers, and requests for improving the ICT-supported delivery of contents:

Whilst the traditional studio culture allows this, there is no doubt that

pressure on studio space and on staff time from increasing student numbers means we are seeing more students working independently away from studio. It is worth pointing out that this is currently in addition to the normal timetable tutorials, but gives students an extra opportunity for feedback and reflection on their design. (p. 51-52).

2.3.1. Investigating communication as a “cognitive ethnography”

Despite the limited studies of the applicability of the aforementioned technologies in design education, there is a concurrent stream of research, which facilitates the understanding of technology-mediated social settings.

Following the definition of “cognitive ethnographies” (Hollan et al., 2000), the challenge of setting a disciplinary frame for this research is to account for design as a social activity, allowing the observation of the impact of technologies within such setting. Studio teaching, in fact, resonates as a context in which a distinctive culture has been developed over time (Cuff, 1991) where different social practices shape the learning process (e.g. design critiques, design juries).

2.3.2. Multimodality as a research approach

Recalling previous sections, design studios rely on a series of pedagogical traditions and habits currently being called for reconsideration, stressed and permeated by extrinsic factors such as new tools and technologies. Design studios operate, at a generic level, by situating students in a project development scenario throughout a semester that is continuously fed by feedback provided by instructors and peers. Starting with a design brief, students set design goals and move across design options as the course proceeds (usually on a semester or yearly basis), and in the limited time-shared with instructors they make use of that feedback and constructive criticism to move on through the design process. As a result in design studios students model, represent, learn and use technology to a high level of complexity.

Take, for instance, physical architectural models as a mean of communication. Models are three-dimensional representations of a project but the messages they convey vary across different people, contexts and authors. A quickly made and sketchy crafted model made by a student might suffice for an

informal design critique session whilst a more elaborated, neat model should be the standard in a final design jury by the end of a studio course. The first model aims to communicate work-in-progress ideas to be reviewed by the instructors while the latter aims to convey detailed design knowledge, demonstrating mastery of modelling methods and techniques to be assessed. Those “messages” are expressed through variations on the materiality and craftsmanship of the models, and are interpreted and understood by instructors and fellow students in the studio (Figure 2.1).



Figure 2.1. A complex assembly of representations made by a group of students being used to communicate a final project in a MArch course at the Liverpool School of Architecture.

The validity of observing models as a communication and perception process stands not only by previous disciplinary examples - which might be familiar with any architecture instructor nowadays -, but also on theoretical work. The widespread publication from Brian Lawson “How designers think” (2005, 4th ed.) devotes a full chapter to view design as conversation and perception. He describes this approach to design largely based on conversations with designers that will ultimately form part of his research presented in “Design in Mind” (Lawson, 1994).

While it can be argued that Lawson switches the focus of analysis between individual design (“a conversation between the designer and the representation”) and group design based on social interactions, in the context of this research it is interesting to review with more detail what he defines as “conversations with

computers” (Lawson, 2005). He states that a fundamental issue to conduct an effective “conversation with the computer” is that, due to technology affordances, such conversation must be done “in the terms of the computer” in relation to the use of symbols and operations – a presence of logical thinking as an active element of a design process.

Whilst he does not describe the use of computers in social systems, it is relevant to mention his (rather succinct) observation on the work of Dreyfus (1992) who describes design cognition as a complex task which can be only supported - yet not replaced - by digital tools in the context of a design conversation. Despite the brief mention, Dreyfus’ work (1992) was later to be quoted in Hutchins’ “Cognition in the Wild” (1995) where he laid foundations for the development of the theory of distributed cognition, thus adding relevance to the roles of symbols and meaning making in cognitive processes. This semiotic approach to cognition is clearly stated by Hutchins as “the entities that are imagined to be inside the mind are modeled on a particular class of entities that are outside the mind: symbolic representations” (Hutchins, 1995, p. 357), and also aligned with disciplinary viewpoints such as Goldschmidt’s work on internal and external representations (1997).

Meaning-making is at the core of social semiotics and communicational dynamics. In systems such as the design studio, conveying meaning through actions, dialogues or artifacts is a basic action of communication. In the words of Theo van Leeuwen (2005) such actions, dialogues and artifacts constitute **semiotic resources**. Those resources for communication embody social interaction through a “grammar” that structures such resources in meaningful ways. Indeed, the construction of meaning is facilitated by the use of a language that does not necessarily comprise speech, as regardless our mainstream use of speech as a communication medium, we also make use of additional semiotic resources whose interaction embodies meaning: models, gestures, gazes, and so on.

For instance, in a design jury session students make use of several communication resources to display their projects: drawings, (moving) images, physical models, speech and gestures. New media, although, offers new insights into design communication, broadening the spectrum of available semiotic

resources for students: video, sounds, or digitally fabricated representations are now within their reach. In the more specific case of AR -derived semiotic resources, those are combined into assemblies across digital and physical media, thus enriching the communication potential of differently and yet meaningfully crafted combinations (Figure 2.2). During the session those resources are structured into a presentation layout and a speech, constructing a narrative structure which describes the project. Such “grammar” assembles the message that students convey towards the jury members for feedback, assessment and marking purposes.

The construction of meaning is then a social phenomenon highly relying on its context; it is in the context of the architectural design studio where the messages carried through models become identifiable and recognisable. As stated by Hodge & Kress (1988), the social dimensions of a semiotic system are intrinsic to its nature so such systems cannot be studied in isolation. Such context, namely “discourse” in social semiotics, is where the assembly of messages take place. Recalling Hodge and Kress (1988), the discourse is “the site where social forms of organisation engage with systems of signs on the production of texts, thus reproducing or changing the sets of meanings and values which makes up a culture.” (p. 6).

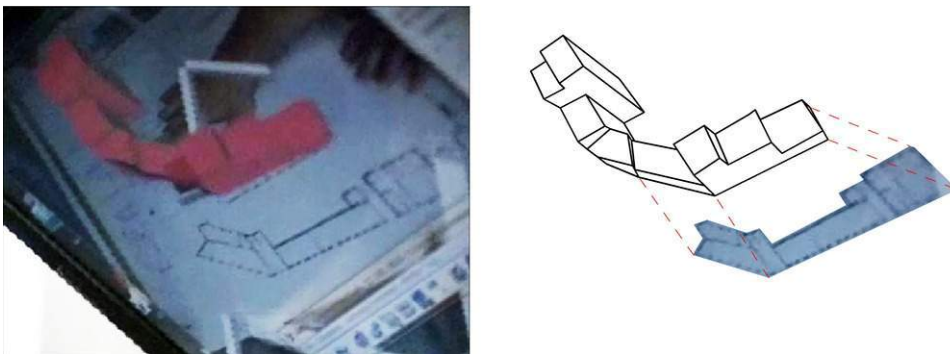


Figure 2.2. Video screenshot - A student describes to the design instructor an architectural model that combines a physically printed floorplan with a 3D model of the building’s form, by using AR technology.

A mode of interaction is a “socially and culturally shaped resource for making meaning” (Jewitt, 2013). Behavioural semiotics was until recently highly focused

on the study of isolated modes of interaction. However, as already seen, learning environments comprise an orchestrated assembly of different modes of interaction. In design studios, representations such as drawings, sketches, images and physical models become means of communication with their corresponding semiotic resources: drawings have resources related to the linewidth, colour, size and scale, and a series of other meaning-making descriptors. On the other hand, images' semiotic resources are related to colour, composition, size, perspective and so on.

Multimodality is a recently formulated research approach to observe these relational ties across different modes of interaction. This approach can be traced back to seminal texts on social semiotics mainly by the theoreticians Gunther Kress and Theo van Leeuwen (Hodge & Kress, 1988; Kress & van Leeuwen, 1996; Kress & van Leeuwen, 2001). Multimodality does not only arise as a scientifically valid way to facilitate the observation of multiple modes of communication, but also as a response to the changing nature of contemporary communication in educational contexts. It relies on the changing nature of texts and language: new digital literacies, technology-enabling modes of communication and computer graphic technologies are radically changing the way people interact in social environments.

Likewise, existing modes of communication have reached higher levels of sophistication and complexity (Kress, 2010). Those changes in contemporary communication have observable impacts in the day-to-day life, such as the rapid shifts between print media and screen displays (new modes of dissemination), or the increasing use and interest of (moving) images as a medium of communication (new modes of representation). Architectural design is not far from this trend as modes of communication are being updated by new technologies: the use of screen as a design interface, the use of computers to support design representations and the relevance of images as means of communication would not be odd to any architecture student and instructor today. While technologies keep being updated and incorporated to designers' work, the visual and dialogical nature of a design process allows to describe design studios as a rather **multimodal space of social interaction**.

Multimodality appears then as a contemporary and relevant approach to

observe social phenomena such as design studios by observing the assemblies and patterns across several interrelated modes of communication. Different communication studies have been conducted in learning environments and amid the recent formalisation of multimodality as a research approach, it has resulted in relevant contributions to knowledge. Its application is particularly interesting over other complex learning environments such as medical education in the operating theatre (as reported in Bezemer, Cope, Kress, & Kneebone, 2011; Bezemer, Cope, Kress, & Kneebone, 2014) or music education (as reported in Falthin, 2011). As a result, multimodality poses itself as a pertinent way to investigate technology in social settings, rendering this approach useful for this research.

2.4. MULTIMODALITY IN DESIGN RESEARCH

The use of different modes of interaction as a mean to observe and describe design processes is not new in architectural research, yet it has been investigated from different methodological and theoretical stances through time. This section describes how previous research has accounted for design as a multimodal phenomenon by observing modes of interaction. A commonality is the observation of design through social interaction by recording and describing modes of communication. Years after “The Sciences of the Artificial” (Simon, 1969), Ericsson & Simon (1980) approached the observation of cognitive processes from verbal data. In the context of a research landscape highly based on behaviourism (their paper was published in the journal “Psychological Review”), verbal data was considered to be not truly representative of cognitive processes.

On the other hand, psychology researchers were probing data from sources considered “more representative” of the sub-conscious or unaware cognitive processes, such as innate eye movement tracking or gestures (Ericsson and Simon, 1980). Given its intuitive nature, these actions have been considered as more truly representative of a person’s cognition, as opposed to speech. Yet still under the assumption of intelligence as an individual and mind-based activity, the work of Ericsson and Simon proposed a methodological approach to take verbal data from an informal stance towards a series of structured procedures

for its collection and analysis in behavioural research. As a landmark for future design research they proposed a structured view of speech-derived data into verbalisations and verbalised “rules”, thus laying the foundations for “protocol analyses” in the context of design research (e.g. McNeill and Gero, 1998). Furthermore, psychology studies using speech as a semiotic resource derived into elaborated research approaches such as the “think aloud” research method, later utilised in the context of architectural education by Hamel (1990) in his work “On the thought processes of architects”. This tells us that speech constitutes on its own a complex assembly of information that can largely account for certain social situations, yet it lacks additional information to allow the depiction of other potentially relevant modes of communication such as gestures and design representations.

Close to Ericsson and Simon’s work on verbal reports as data, an ethnographic approach was being used to observe architectural design education in a postgraduate Architecture course in the United States. A study submitted on the late 1970s in fulfilment of the requirements for the PhD degree of Roger Simmonds at MIT (1978) observed architecture studios to understand individual learning dynamics of design students based on the dialogues between instructor and students. This project entitled “Learning to learn and design: the development of effective strategies in a graduate School of Architecture” was supervised by Professor Donald Schön and constituted part of the data collection that was later utilised in the construction of his theory of “reflection-in-action” in professional disciplines (Schön, 1983). It is worth reviewing both research processes and how are they related, given that Schön’s work is not only a foundational theoretical contribution to educational research in architecture, but additionally made a relevant formalisation of related modes of communication to understand how reflection is embedded into a design critique dialogue.

Simmonds conducted interviews and spent half of the studio teaching hours focused on the individual learning processes of 12 students in relation to one instructor, known in the literature as “Quist” (Simmonds, 1978). Even if his dissertation was mainly based on speech as a mean of interaction and data gathering, he points out that during the research process attention was also put

on Quist's "written handouts, programs and task designs and teaching behaviour" (p. 3). Different means of interaction between students and the instructor then shaped the theory construction process, and initial theoretical categorisations were additionally supported by individual interviews conducted with students.

Schön, on the other hand, focused on the "reflection-in-action sequence" of design critiques between "Quist" and a single student, "Petra" (1983). As opposed to Simmonds, Schön makes use of speech and drawings as a way to describe the feedback and dialogues across the two participants. Schön transcribes sections that illustrate the reflection-in-action sequences, and specifically those sections that seemingly require the construction of representations in the form of sketches. For instance, part of the instructor's transcribed dialogue is:

Let the land generate some sub-ideas *here*, which could be very nice. Maybe the cafeteria needn't be such formal function - maybe it could come into *here* to get summer sun *here* and winter *here* (p. 89, highlights are mine).

Not reproduced in its original form and despite the editorial challenges of reproducing sketches in 1983, images of the representations help the reader to understand what Quist meant with the location adverb "*here*" as a part of the project being designed by Petra (Figure 2.3) and criticised in regards to the layout of a school in relation to a sloppy plot of land - the given design brief. This early reported use of drawings as a mode of interaction supporting speech derived into an underlying structure, a sequence of actions and dialogues that ultimately embody the "reflection-in-action protocol" (Schön, 1983).

In addition to Schön's use of representations to support his claim, it is relevant to note the way architectural research methods have depicted multimodal communication as a mean to observe design activities, even before multimodality was formalised as an approach within communication research. In the work of Hamel (1995) he explicitly couples two modes of interaction: design moves and speech. His previous work was mostly focused on the "think aloud" research method based on recording spoken thoughts of designers during an experiment. As he states,

We gathered two kinds of data. Firstly, a record was kept by the computer of every attempted move, together with its outcome, the state of the puzzle, and the time per attempt. Secondly, our subjects worked on the puzzle thinking aloud. The verbal protocols are data reflecting the information on which the subjects' attention was focused. (Hamel, 1995. p. 55)

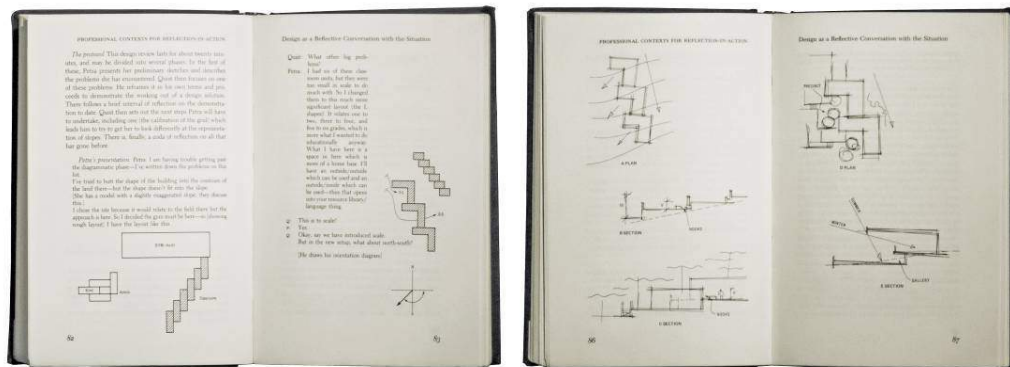


Figure 2.3. Donald Schön's "The Reflective Practitioner" (1983) with drawings to illustrate the dialogue between "Quist" and "Petra". Pages 82, 83, 86 and 87 are here reproduced with permission from Perseus Book Group.

The work of Hamel is, however, not isolated on the use of more than one mode of communication in design. On a widely cited work, Nigel Cross (2001) reviews protocol analyses in different design-related disciplines between 1970 and 1999. He recalls protocol analysis as "most likely the only method" able to unravel the cognitive abilities of designers, as it is based upon the close observation and mapping of design actions ("moves") throughout a design process – a process usually conducted in rather controlled environments such as lab trials. Cross concludes that the research process related to protocol analyses comprises "modal shifts" since "especially during creative periods of conceptual design, designers alternate rapidly in shifts of attention between different aspects of their task, or between different modes of activity" (Cross, 2001, p. 17).

Those modal shifts have been identified in more recent research, such as Mewburn's (2011) account of gestural communication in architectural design studio settings. Among her conclusions, she claims that gestural communication is also deeply rooted into the architectural design education praxis, as gestures in the studio are performed in "an architectural way" despite they usually operated

below the threshold of conscious awareness.

As can be identified in relevant literature, there have been specific approaches and methodological stances to the observation of modes of interaction for design research. These reviewed works do not attempt to be a comprehensive list, yet a collection of relevant approaches that constitutes seminal disciplinary research landmarks. Even though none has specifically used AR tools to understand the interaction across participants, there are relevant lessons learned which frame this work into the disciplinary landscape or educational research and social semiotics.

In that sense, there is a set of commonalities that closely resonates with the emergence of contemporary multimodal studies in design education research. Firstly, monomodal research has evolved into a multimodal account of the design activity. What was initially focused in stand-alone semiotic resources - such as speech- has derived into different research approaches that comprise diverse and related modes of communication. Related research also concurs in the existence of underlying structures orchestrating such semiotic resources. Whether oversimplified (such as in the linearity of protocol analyses) or attempting to reflect in depth particular dimensions of the design activity (such as the study by Roger Simmonds almost exclusively based on verbal reports), it is a commonality to find ways (namely protocols, sequences, structures, grammars, and so on) in which semiotic resources are assembled in specific contexts.

Relevant for this research, it is also possible to trace the modes of communication that have been typically used to observe design as interaction. In the first place, **speech** comprises verbal data (Ericsson & Simon, 1980) from which designers' insights can be collected. Speech has been utilised, however, in different ways: some works have transcribed the dialogues taking place throughout a design conversation (Schon, 1983; Simmonds, 1978) whereas others have utilised speech as a think-aloud method to elicit the actions performed by individual designers (Hamel, 1990). The core difference between both methods is their most suitable context of application: while the former has been widely utilised in design studio settings through recordings, observations and interviews, the latter requires a more controlled environment and a rather specific design task, so the designer is able to verbalise and explain his actions.

Given that this research is situated in design studio settings, the former approach better suits as a way to observe this specific mode of interaction.

Secondly, **actions upon models** have been reported in previous literature as a component of design interaction (e.g. Mewburn, 2011). Those actions have been usually constrained to the construction of models, such as the hand-made drawings reported by Schon (1983). However, **gestural communication** has been found to not only comprise gestures with/upon models and representations, but it can be understood as an elaborated mode of communication on its own. According to Mewburn's (2011) research on the topic, the involvement of gestures in architectural dialogues also takes roles of "explaining and describing architectural composition", and "conveying the phenomenological experience of occupying architectural space" (Mewburn, 2011). As a result, those three different yet interrelated modes of communication can be considered as relevant to understand interactions within architectural design studios, and particularly throughout face-to-face interactions: speech, actions upon models, and gestures. In this research, these three modes of communication are to be used to describe, then, the face-to-face interactions taking place whilst students make use of AR representations, and a methodological approach to operate within such contexts, including the data gathering, transcription of those modes of communication and their subsequent detailed analysis, is to be developed in **Chapter III**.

2.5. TRACING MULTIMODALITY IN THE USE OF WIKIS

After the previous section focused on relevant modes of interaction encountered in face-to-face communication, this section addresses the differently composed modes of communication in Wikis.

Conversely to the analysis of face-to-face interaction, on-line supported communication has been scarcely observed in the context of architectural education. Wikis for on-line communication operate differently than face-to-face communication, for various reasons. Firstly, it is not a synchronic mode of communication occurring in real-time, but instead is an asynchronic mode of communication - people can visit and interact through on-line resources at different times and places. These interactions do not occur based on the same

modes of communication as in face to face interaction, but instead on different modes inherently used in on-line environments: images, multimedia (video, sound) and texts, therefore making use of different modes of representation. Secondly, on-line communication operates within different modes of dissemination of contents - usually a computer screen, thus constraining the wide array of modal resources available in face-to-face interactions in architectural design studios to what can be displayed and seen in a screen's technical capacity.

This new type of communication has been one of the tenets of the development of multimodal studies - starting by the landmark publication by Kress (2003) "Literacy in the new media age". The core argument of this work is that new multimedia literacy is not only a matter of language, but that meaning-making is actually embedded into a series of more intricate modes of communication involving multimedia design. The recent work from Domingo, Jewitt & Kress (2014) about writing in online contexts (such as blogs or Wikis) results in the identification of three relevant properties of on-line contexts resulting from the way contents are communicated: reading paths and authority (i.e. the design of reading sequences as a way to exert authority over the online content), cohesive devices (i.e. the way the online messages are structured in a coherent manner in order to target specific audiences), and modular navigation (i.e. the overall organisation of a site through "modules" and clusters of information on screen). The source for this group of properties is the observation of blogs, and they make reference to different elements of the website layout and its authoring:

... the social feature of authority: that is, it points to how the text was made and by whom; and its arrangement tells the reader how to read the text: where to start reading, how to continue reading, and, through that, tells how to 'get the' meanings of the author. Authority and authorship are entirely intertwined. (Domingo, Jewitt & Kress, 2014 p. 5)

Such elements are relevant to mention, given the intricate nature of on-line text-making and its relevance for this research. In the first place, those three properties situate writing in on-line contexts as not only an issue of isolated pieces of information (namely written texts or images), but are actually referred

to the overall site layout as a mode of communication. The way those resources are assembled results in purposefully designed ways to “write”, through modularity, cohesiveness and readings paths (Domingo, Jewitt & Kress, 2014). As the authors put it,

Semiotically speaking, writing now has to be considered first of all in its environment of multimodal textual ensembles and in the wider environments of the connections of various digitally instantiated sites. (p. 16)

In architectural education, some explorations of the use of Wikis have been conducted. After an early exploration of the use of Wikis to support a design studio reported by Lindquist (2006), there is a stream of research in the field conducted at the Liverpool School of Architecture (Knight & Brown, 2007; Knight & Brown, 2010; Kocaturk et al, 2014). The work of Lindquist (2006) is focused on the use of Wikis to support a site analysis and early stages of a design development in a design studio course at the Victoria University of Wellington. It is reported that students used Wikis to: collect data about the site, to transfer information throughout the design process, and to present contents. Despite the fact that this was an early exploration not entirely focused on multimodal communication, it is relevant that the author indeed highlights the different media utilised by different groups of students and how it that content organised for various tasks:

Students used the Wiki as an online repository for collected data; photographs, scanned and downloaded maps, images and documents (...) Students used image editing software to make alterations and additions to the plan (...) Group 1 used individual pages that linked to the next page in the presentation at the bottom of the active page, Group 2 used page links at the bottom of a main title page and Group 3 used side menu links to each page of the presentation (p. 193-194).

Those observations confirm that the way students operated the Wiki sites is intended to be based on diverse media elements, assembled into different types of layouts in accordance to each group’s work. Also relevantly, Lindquist (2006) reported the usability of Wikis for student-instructor communication and the benefits for dynamics outside studio teaching times. Such interaction was

reported in different temporal frames, by monitoring students' work, by providing constructive feedback, or by finally recording the full story of such interactions as part of the Wikis' functionalities. Similar outcomes have been reported in related experiences, such as the use of Wikis to support a design studio at the University of Liverpool (Knight & Brown, 2010). Authors claim that the use of Wikis was mostly focused on the monitoring of a "design diary", with constructive feedback from peers and instructors throughout the design process outside teaching times. In the case of Lindquist (2006), additionally, Wikis were used as presentation material and therefore involving not only constructive, but also summative feedback.

"Reflective and dynamic use of Wikis to support collaborative design learning" is a project funded by the British Higher Education Academy (HEA), conducted at the University of Liverpool and led by Dr Tuba Kocaturk at the Liverpool School of Architecture (Kocaturk et al, 2014). After previous experiences which more broadly explore the potentials of Wikis to support design education (Knight & Brown, 2007; Knight & Brown, 2010), this project specifically addresses the potential of such on-line environments to support individual, collaborative and guided learning in design studios, and it is the context from which data for this research is collected. Evidence collected throughout a studio course shows that Wikis have a relevant impact in issues such as labour division, group communication and workload, as well as important design decision-making throughout the use of models and representations. In this case, students used a variety of media and following the findings of previous research, communication across peers and instructors outside teaching hours is a relevant way to monitor students' work and to complement face-to-face feedback sessions with on-line comments. In that sense, Wikis were observed to contribute to both the design process, as well as to the studio's social dynamics (Figure 2.4).

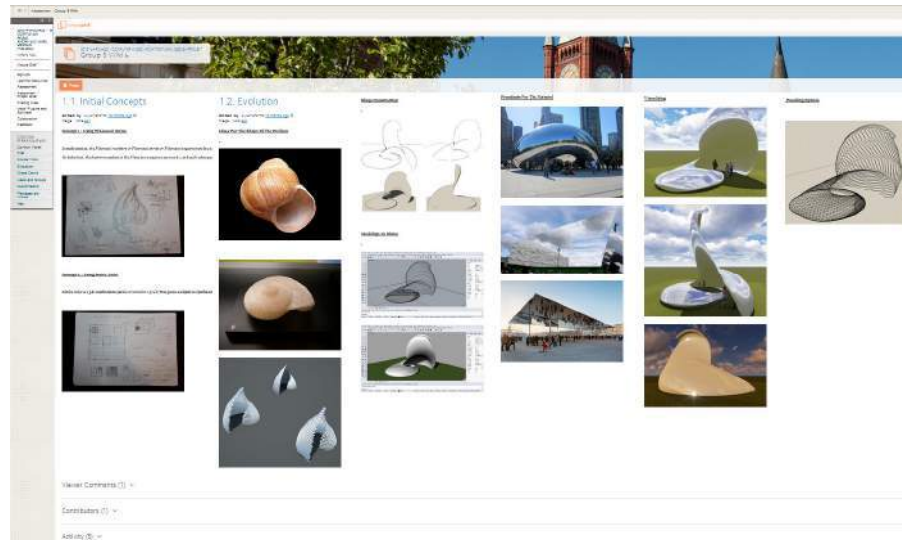


Figure 2.4. Screenshot of the Wiki site developed by group 5. Source: designpedagogy.org.

Throughout this experience, elements of interaction, which until now have not been fully reported in previous research, add new layers of information to the understanding of on-line supported communication. For instance, **text** has been constantly utilised by students and instructors using Wikis. A more detailed account for the use of text can be found in Kocaturk et al (2014), considering not only texts written by students as part of their Wiki sites, but as text that embodies a bidirectional communication across author and audience between members of the studio, via comments. Additionally, some groups of students made use of text to record minutes of their group meetings and communication.

Images, likewise, are broadly used by design students to document and record their design work, and despite the availability of diverse on-line media it still largely remains as the core representational technique - including drawings, renders, simulations or scanned versions of hand-crafted materials such as notes and sketches. This varied use of images could be found in every reviewed experience in the context of architectural education, reinforcing the visual nature of design knowledge representations in the design studio.

As exceptions to this pattern, the work of Knight & Brown (2010) suggested the use of audio feedback to students, and in the case of the work of Kocaturk et al (2014) there is a limited use of additional media resources, usually expressed as external links to on-line videos (Youtube) or presentations (Prezi).

Finally, it has been acknowledged in the literature that **layout** - the assemblies between different resources (Kress, 2010) - plays a major role on how contents are communicated, and how the reader's navigation of the sites is facilitated by properties such as cohesiveness and modularity of blocks of information (Sakr, Jewitt & Kress, 2014). As a result, those three different yet interrelated modes of communication can be considered as relevant to understand interactions within Wikis for architectural design studios: texts, images and layouts. In this research, these three modes of communication are to be used to describe, then, the interactions taking place whilst students make use of Wikis in the design studio, and a methodological approach to operate within such contexts is to be developed in **Chapter III**.

2.6. SUMMARY AND CONCLUSIONS

There is little doubt about the relevance of media in contemporary design and design education. Likewise, little can be argued against the increasing use of novel technologies and media to model, represent and communicate design. It is in this changing context, with emerging and evolving modes of communication and representation, where multimodality contributes to the description and understanding of the social fabrics in the design studio. Even if not the only valid approach to the understanding of teaching and learning dynamics, multimodality has implications that fit with the purpose of this research.

This review has highlighted the relevance of understanding the social semiotics of design studios, and posed multimodality as a contemporary and pertinent research approach to such understanding by both challenging and building upon previously used approaches to design research. Despite the updated perspective that multimodality asserts, it has been also acknowledged that the nature of design representations and design studio teaching already involves relevant elements of multimodal communication, both in face to face and in online environments. This is a relevant step towards the answer of the research question which structures this thesis, and also relevantly complies with the first objective of this work, which is to **situate architectural design pedagogy in the context of communication studies and contemporary educational research**.

The particularities of design studios shape an interesting setting in which multimodal research can be used as an observational lens. Rather than becoming “architecturally literated”, students are taken through an acculturation path in which they become members of a disciplinary community. Loaded with highly established social and cultural practices, the design studio poses pedagogic challenges way beyond knowledge delivery and production but also on the social ties and power dynamics that shape students “into” architects.

Previous research, even if not focused on technology-enhanced learning in design studios, has observed design education as interaction and relevant modes of communication can be identified. Moreover, previous theorisations of studio education (Schön, 1983) rely on communication studies as a way to depict social dynamics across students and instructors in the studio. In a way, multimodality can be considered as not only a challenging path towards an updated understanding of studio pedagogy, but instead as a research approach comprising an evolutionary continuity of previous works, and as a rich procedural resource (e.g. methodology) for implementing such approach.

As a result, a disciplinary frame can be outlined based on the observation of design as interaction in social settings. This frame relies on both theory of design research and illustrative relevant previous works, and is bounded by knowledge derived from design, technology-enhanced learning and social semiotics research. Different theoretical and methodological standpoints have been used to observe design as interaction. This disciplinary analysis, far from being comprehensive, sets this research into a multimodal context by selecting relevant previous experiences that illustrate both the migration of design research from monomodal to multimodal accounts of design activity, and the use of structuring resources to describe such activity.

In more detail, relevant modes of interaction have been identified in previous research in order to observe the use of AR models in face-to-face design studio interactions, and the use of Wikis for on-line supported communication. Whilst the former context will be observed by eliciting modes of interaction such as speech, gestures, and actions upon models, the latter context will be focused on the observation of communication through text, images and layouts in Wiki sites.

The following **Chapter III** describes how I operate within this given disciplinary context. A particular set of methods has been built upon the need to access the field to collect primary data, transcribe the relevantly identified modes of communication, and its subsequent analysis for the theory construction.

CHAPTER III

**RESEARCH FIELDWORK:
CONTEXTS AND METHODS IN
DESIGN STUDIO SETTINGS**



Extract from fieldwork notes and video records

A design critique dialogue between a Giacomo and his instructor is suddenly interrupted while I am still video recording. They are trying to display an AR model on a laptop screen, and I try not to influence or participate in the actions whatsoever. The 3D model is not visible and Giacomo needs some troubleshooting advice, so he looks at me and says

Giacomo	Excuse me, but the window is not changing the (.) selecting the (-)
Me	Ah well, that's probably because of the light in the room (.) it has to recognise very sharply the pattern-
Giacomo	Because it is there! ((laughs))
Instructor	Because it is higher!
Me	Well, that's because the location of the model

The model is not properly edited, so it cannot be shown on the laptop screen - the location of the model is wrongly set. The conversation goes on with my participation to fix the technical issue for the next couple minutes.

3.1. INTRODUCTION

As already reviewed, the construction of a disciplinary frame to observe communication in design studios is inherently multi-faceted and multi-disciplinary. Once a disciplinary framework is set in **Chapter II**, this chapter is dedicated to the resources required to conduct this research within that given frame, and specifically the methods utilised to identify and record the relevant modes of communication embedded within the investigated studio interactions: AR-supported face-to-face communication and online communication using Wikis. For such purpose, each fieldwork setting is here described and its associated research rationale, methods and techniques are detailed. Likewise the practicalities, challenges and limitations considered to access the site, observe the relevant actions, and record data are here mentioned.

“Data” here is considered as a twofold resource. Firstly, it serves as the raw material that allows constructing the outputs of this research by following a grounded theory methodology (a conceptual vocabulary, a pedagogical framework and a theory). Data is then gathered by several means in different contexts, and contributes with the relevant incidents that provide a ground for the coding and subsequent incrementally refined theoretical construction process. On the other hand, additional information has been collected to allow a more accurate interpretation of the data, a deeper understanding of the informants’ perspectives and insights, and a resulting more comprehensive description of the observed communication phenomena in context.

Considering the different international fieldwork settings and cultural backgrounds of the informants, this information became an invaluable resource to situate the observations and keep moving through the research process. In that sense, the array of methods presented in this Chapter are not only those devoted to collect data for the construction of the theoretical outputs, but encompass a broader and more comprehensive review of how fieldwork was conducted in various design studio settings.

3.1.1. Structure of the Chapter

Each fieldwork setting has been selected to incrementally contribute with additional data to the research process, therefore methods vary accordingly. It must

be recalled that after the construction of the disciplinary framework, this set of methods have been tailored to fit within and, as a result, the methods described here are pertinently aligned with ethnographic research techniques (e.g. participant observations, interviews with informants, records of on-line communication, among others), and therefore with qualitative research methods. This distinction is relevant considering that quantitative methods can be also utilised as a resource of a grounded theory (Glaser & Strauss, 1967) - yet have not need utilised in this research, given its approach focused on observing a social setting rather than on measuring specific variables.

In a more detailed account of the canons and criteria for selecting research methods in the context of a grounded theory, Corbin & Strauss (1990) address the distinction between the qualitative and quantitative canons and procedures, including those that until then were usually associated with quantitative research such as significance or generalisability. As later published by Glaser & Strauss (1994), both types of data can be utilised (in some contexts, actually, they claim that the mix between both approaches might be necessary) and yet, it has been mostly adopted by qualitative researchers from various fields by various reasons. As a result, this trend has granted grounded theory with a mostly qualitative nature through the development of additional theoretical and disciplinary underpins, procedural guidelines and canons for “good science” from a qualitative perspective.

First, a set of methods to explore face-to-face interactions in design studios using AR technologies are described. In order to observe, record and subsequently analyse the intended modes of communication (speech, gestures and actions upon models) video recordings of design critique sessions are utilised, as well as interviews with informants and participant observations in two parallel design studios, on an overall timeframe of 3 weeks.

Following this section, a series of methods to observe on-line communication, and particularly the modes of interaction comprised by text, images and layout in such environments are described. Differently from the previous experience focused on face-to-face interaction, this group of methods addresses the need to understand students’ work outside studio teaching hours, therefore a constant monitoring of the groups’ work was required throughout a longer time span of fieldwork research.

The last group of methods described in this Chapter is that of the research

techniques used to explore the applicability of the resulting outputs of this research, in context. Grounded theory produces outputs that are inherently applicable to its context of operation. Nevertheless further investigation was conducted by understanding how different instructors, their teaching approaches and their perceptions about technology-enhanced learning affect the limits of applicability of the theory in different educational scenarios. For this purpose, a group of anonymous semi-structured interviews with design instructors as well as observations in design studios were conducted at the Liverpool School of Architecture.

Finally, the last section of the Chapter presents a summary of the utilised methods and reflects upon the challenges, limitations, and further work to be considered to build a methodological apparatus to explore the architectural design studio as a social setting. The Chapter ends by drawing upon conclusions and the compliance of the proposed methods with the objectives of this work.

3.2. PARTICIPANT OBSERVATIONS IN DESIGN STUDIOS

Several observation sessions have been conducted in undergraduate Architecture studio courses, both with and without the influence of AR tools for their work. The integration of technologies in these courses has not been particularly disruptive, since training and technology tutorials are commonplace in their curricula in that level of study (3rd year). Concerns have been focused on the identification of the participant observer, the invasiveness and influences of my own actions into the observed dynamics, the changes to be made to the planned research methods whilst maintaining the integrity, quantity and quality of the data. While this Chapter is focused on the research methods utilised throughout participant observations, a more detailed account of the ethical considerations in place can be seen in detail in **Appendix V**.

The opening words in this Chapter are transcribed verbatim from the video recordings of design critique sessions. After some days of technology induction and training, students made use of augmented reality (AR) tools to support the visualisation of their models, by building small augmented representations and displaying them as part of the communication with the instructors. Video recording has been chosen as the method to observe and record the fine-grained set of modes of communication required at this stage of the research: speech, gestures and actions

upon models. This was not a lab-based user trial but instead data was gathered on the context of an actual working design studio, and recorded in detail for more detailed observation and analysis. After some minutes of observational work my role shifted towards that of an active participant of the actions - answering questions from students, or providing troubleshooting advices.

This situation, together with other fieldwork experiences, later led to a series of notes and reflections in relation to the role of the researcher on the design studio as a fieldwork setting, and the construction and use of a toolkit of methods to observe such context.

3.2.1. Site selections

Early explorations of the use of AR in design studios were conducted in the MSc Digital Architectural Design at the University of Salford. More specifically, a small course of 24 postgraduate (and mostly international) students working in the design studio is the initial testbed for this study. Given the contents of the course, software training is commonplace and no disruption has been produced by adding an AR training session. While the contents of the course predispose students to the area of enquiry, this site selection obeys only to the need to prematurely identify the limitations, challenges and fieldwork recommendations for this study, and no data has been coded as part of the theoretical development process.

The observation of AR-mediated communication was conducted at the Polytechnic of Turin, in Italy. This School of Architecture has high numbers of students, thus allowing me to observe different parallel 3rd year undergraduate design studios. Then, the observation of on-line communication in design studios was conducted at the Liverpool School of Architecture (University of Liverpool), in a MA design course.

Finally, the limitations of this work have been explored through a series of interviews with design instructors, with teaching duties that range from 2nd year undergraduate courses up to postgraduate level teaching and research supervision. Additionally, some of the interviewees have a prominent experience in the architecture professional practice that pervades their teaching approaches. These interviews have revealed how the resulting theory can be utilised to identify, describe and compare diverse technology-mediated teaching approaches.

The choice for different settings provides a variety of sources and types of data that allow a rich set of incidents to be utilised for the theory development, including newly developed sources not originally included in the work of Glaser & Strauss (1967), such as communication in on-line environments. The rationale for choosing different settings for this research is twofold:

- A workshop-based enquiry provides useful and novel primary data for our discipline. This ethnographic and experimental approach is aligned with the development of a grounded theory which is built upon relational ties between the theory and the context it comes from.
- Secondly, the observation of different settings and types of data, diverging students' backgrounds, institutional standpoints and instructional approaches results into a wide and rich picture of studio teaching and learning dynamics.

Sampling and access to the site are critical steps in educational research. In "The Discovery of Grounded Theory", Glaser and Strauss (1967) dedicate a full chapter to sampling during grounded theory work, namely "theoretical sampling". Theoretical sampling is the process of sensitively selecting the slices of data, which contribute towards the theory construction process. This process is particularly relevant from early stages of research, in order to carefully construct the theory avoiding data overloads, and leaving aside pieces of data that are not aligned with the intended research questions. Theoretical sampling then proceeds as the research process goes on, and rather than selecting data collection contexts and groups, it responds to the new hypotheses and questions being developed throughout comparative analyses. As they state, the

basic question in theoretical sampling (in either substantive or formal theory) is: what groups or sub-groups does one turn to next in data collection? And for what theoretical purpose? In short, how does the sociologist select multiple comparison groups? (Glaser and Strauss, 1967. p 47).

However, Glaser himself also warns theoreticians about what he calls the "worrisome accuracy" of data collection with high levels of detail such as interview recordings (Glaser, 1998). His concern lies on the conflicting and possibly inaccurate ways to "filter" the data and keep the theoretically relevant information. For this purpose, only relevant slices of video recordings have been isolated and utilised for

the coding process. For instance, after video recording 6 hr of AR-mediated design critique sessions, only relevant video sections in which students and/or instructors can be actually seen making use of AR technology are utilised for the research process, while the rest of the recording serves as contextual information for the data interpretation and analysis stages.

The selection of the observed sites in this research responds to the need to identify, describe and comparatively analyse the different ways multimodal communication operates in design studio settings, whilst keeping a systematic alignment with the theory construction process. In that sense, fieldwork sites are strategically chosen to observe the intended communication phenomena following the aim of this research. In more detail, the intended outcomes of the sites selection obey to the need to

- Identify the variables that describe multimodal communication design critique sessions, in order to build a conceptual vocabulary that explains these communication dynamics.
- Identify the variables to describe multimodal communication using Wikis in design studios, in order to expand the conceptual vocabulary and relate such concepts into categories.
- Discover correlations across diverging teaching approaches in architectural education, in order to outline the applicability boundaries of the theory.

As a result, each fieldwork site acts as an independent stage of this work whilst still framed within a larger process of theory construction - once the initial theory construction stages are fulfilled, the following allow incrementally deeper refinement, by testing and continuously expanding the theory outcomes (Figure 3.1).

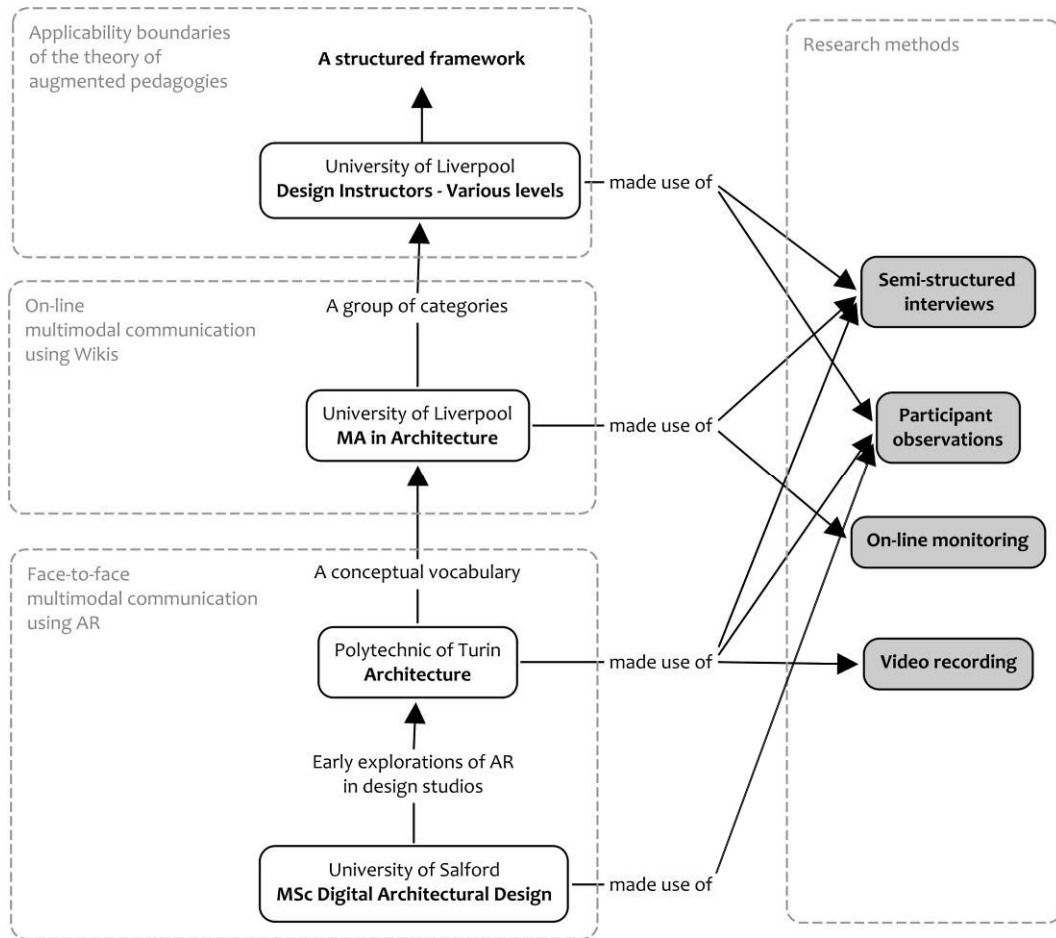


Figure 3.1. Summary of selected research methods utilised in the different stages of this research.

3.3. PRELIMINARY STUDY: TECHNICAL AFFORDANCES AND CHALLENGES OF AUGMENTED REALITY MODELS

Early explorations with AR models have been conducted at the MSc Digital Architectural Design of the University of Salford. These experiences are fully reported in (Veliz, 2013 - **see Appendix I**). The opportunities of AR-based models have been studied in a design studio context, and therefore outlining the challenges and limitations of AR technologies for design, as well as the first considerations and recommendations for further data collection in this research.

3.3.1. Lessons for data collection

This initial exploration is not intended yet to depict the pedagogical impacts of AR technologies for studio teaching, and no theory supporting data has been collected. Instead it aims to initially spot the challenges and limitations of AR models

in the context of a design studio course, as well as to support further planning of additional fieldwork experiences in other locations. Among the relevant lessons learned, little training time was always required and designers were able to combine different types of models effectively (Figure 3.2).

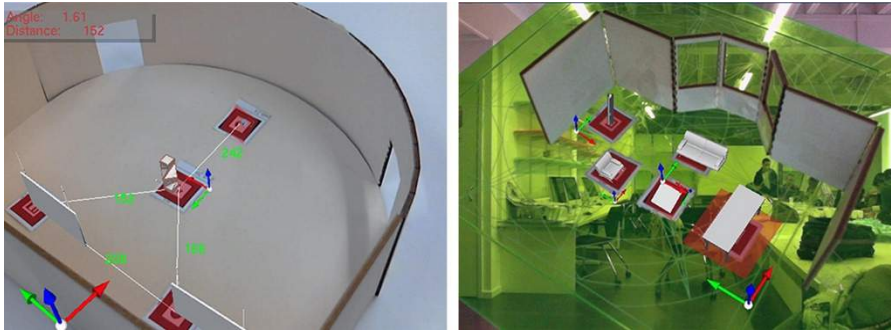


Figure 3.2. Sample models developed by students. Left: Augmented model to study the layout of an exhibition space. Right: A furniture layout model.

AR models provide a ground for additional representational elements, in addition to the use of 3D geometries, such as distance measuring functions that were quickly grasped by students (Figure 3.3). Such features add a new semiotic resource that in the case of the “distance measuring” function is expressed through lines and real-time annotations on screen, resulting from the physical manipulation of the model. Such information emerges exclusively as the result of coupling physical and digital information and cannot be utilised without the use of AR tools.

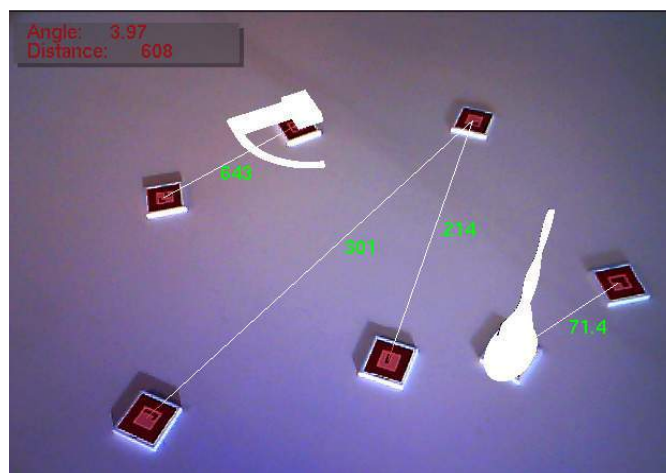


Figure 3.3. AR-supported distance measuring functions.

As experiences throughout the workshops, limitations of AR models are mainly related to the current computer interfaces and tutoring workload. The use of the computer cameras for the visualisation of models and the screen as a visualisation media merge the modes of dissemination and representation into single devices. While technical properties of such hardware constrain the quality of visualisation (camera resolution, screen size or environmental lighting, for instance) it also impacts on the mode users interact with the model, whilst attempting to display their models properly. This technical condition then restrains the ways in which users make use of gestures, and their actions upon the models, therefore mediating such elements of communication.

Tutoring workload also proved to be a challenging condition. Even though the technology inductions do not directly impact on the communication of AR models during design studio observations, it certainly does on its training and production stages. Given the constraints of the architectural curricula in the observed contexts, it is challenging to allocate time for tutorial purposes outside the formal teaching hours, or to assemble AR-related contents to existing design briefs and modes of delivery. Nonetheless and given the variety of contexts observed throughout this research process, further workshops then are conducted outside teaching hours following an agreement with local instructors and students.

It can be concluded that despite challenges and limitations, AR models can be implemented in studio courses and valuable information has been sourced in order to implement this research process within variety of research settings. AR has proven to be a way to broaden the array of communication resources by which designers can communicate their work. In order to plan effectively further fieldwork experience and based on these preliminary explorations, it can be summarised that an awareness of the students' technical background for representing design knowledge, awareness of the existing hardware limitations as well as the technology induction workloads are the core dimensions that need attention to conduct an efficient research fieldwork without comprising the integrity and quality of the observed studio courses. This operational knowledge was to be in use during the following research fieldwork experience at the Polytechnic of Turin, devoted to the observation of face-to-face interactions in design critique sessions using AR models.

3.4. METHODS TO INVESTIGATE FACE-TO-FACE INTERACTIONS IN DESIGN CRITIQUE SESSIONS

Following the preliminary experiences conducted at the University of Salford, this section described the methods utilised to record AR-mediated communication in design studios. This fieldwork research was conducted in April 2013 during a research visit to the Polytechnic of Turin, in Italy. The utilised methods are those of video recordings, participant observations and semi-structured interviews with informants.

3.4.1. Video-recording design critique sessions

With many simultaneous actions in the same physical space of a design studio course, and each one comprising relevant modes of communication, a careful account for video recording as a research method must be highlighted. During the video recording process, and regardless careful search in the data for communication patterns, several decisions must be quickly made on-site: when should be the camera turned on and off, how to focus the camera field of view on specific actions inside the design studio, or when are peripheral activities left aside the recording process (e.g. Mewburn, 2009). The positioning and activity of the video camera is, in that sense, fundamental for rich data collection (Luff & Heath, 2012) and according to Jewitt (2012) it seems to be an agreement across social sciences in that the camera should point towards pertinent actions, and disrupt it as little as possible.

The distinct situations in which AR models are displayed comprise the initial data sources for this research. 6 hrs of video have been recorded throughout four studio sessions (Figure 3.4).

Such records have been filtered to only keep the sequences in which students made use of AR models to interact with their instructors, and its detailed transcription and the initial coding process can be seen in **Appendix II**. Nevertheless, the full records of the critique sessions provide a detailed understanding of the context, attitudes and commonalities from instructors and students contributing towards data interpretation.

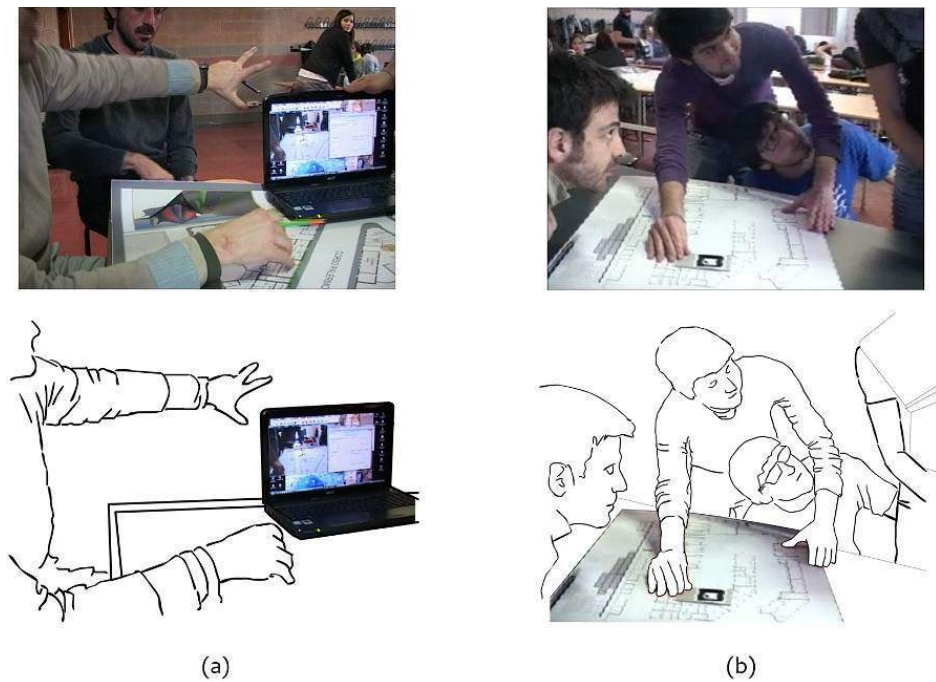


Figure 3.4. Sample video frames of participants interacting with AR models.

Considering the challenges being faced when using video in a studio setting and its consequential impacts on the theory construction process, a series of countermeasures have been taken. While no research method will completely reflect an undisrupted social fabric, these countermeasures account for a carefully conducted data collection, ensuring data validity:

- **Combination of video recording techniques with other research methods.** Throughout the data collection process observational notes and sketches were taken as a mean to record initial insights about studio organisation, students' behaviour, the structure of design critique sessions and personal thoughts about the research procedures and methods. As a matter of consistent research praxis, notes and memos were taken in studio sessions before and after video recordings and immediately transcribed into a digital archive during fieldwork. **Appendix III** includes brief sample fieldwork notes and sketches made during this stage.
- **Participants' post-recording validation.** After the video recording sessions, randomly selected students were asked for short semi-structured interviews to verify observations made during the data collection procedures. This countermeasure supplied not only a data quality assurance

procedure but also additional information about students' perspectives. As a result, this research procedure is aligned with the claim of using video recording not only as a gathering technique but as an actual "broadening resource" for observational research. Requested of their thoughts on the usefulness of AR models, an illustrative answer is given by a student as he states:

"I haven't seen anything like that; I didn't imagine it exists (.) (-) maybe in the **cinematographic dimension**, where you can use this **virtual creation of elements**. It's like a new world, many possibilities of capturing an object that doesn't exist (.) it's exceptional to see and **have in my hand** an object that is not in my hand. (translated from Italian, highlights are mine)."

- The third counteracting measure to ensure the validity and quality of data is that of the **length and continuity of the observations recordings in the design studio**. Previous research highlights that observed subjects become less camera conscious as the research proceeds and tend to "forgot the camera effects" in their behaviour (Lomax & Casey, 1998). In that sense, a constant presence in the design studio together with the AR training sessions made students familiar with the research procedures. Aligned with precious research such as Heath, Hindmarsh & Luff (2010), shortly after the commencement of the recording process, "the camera is made at home" and receives little or no attention by the participants.

Finally, prior to the data analysis the video records are transcribed into a "workable" format (**Appendix II**). Such text-based transcriptions describe the dialogues, but also verbalise the gestural communication dynamics and make use of images to describe actions upon models. Such multimodal transcription (Flewitt, Hampel, Hauck & Lancaster, 2009) is aligned with the purpose of this research, as well as accounting for the observed interactions across the informants.

3.4.2. Students' semi-structured interviews

Semi-structured interviews were conducted with a randomly chosen group of 6 students, on an attempt to understand their design background, as well as their perception of technologies for design. This information was recorded on short 10-15 minutes interviews, and was proven useful when certain video recorded incidents

(such as troubleshooting requests or guidance given by instructors) needed further interpretation for theory construction processes.

International students seemed to understand and to fit within the studio culture at the Polytechnic of Turin (international students came from Romania, Spain, China and Mexico) thus confirming the ubiquitous nature of studio pedagogy assumed for this research. Students had also a similar technology background: most of them had previous knowledge of some digital tools such as AutoCAD and Sketchup. It is relevant to point out, likewise, that there are few or no software training modules in the architectural curricula of the Polytechnic of Turin. Instead, representational tools are mostly self-taught and the “technology studio modules” (such as the ones observed for the purpose of this research) deal mostly with building technologies instead. Given the limited operational knowledge of more advanced digital tools for representation and visualisation, every student interviewed for the purpose of this research considered AR as a novel tool and referred to it with rather interesting metaphoric nouns and descriptors, such as the “cinematographic potential” for “the virtual creation of elements”.

3.5. INVESTIGATING STUDENTS’ COLLABORATIVE WORK USING WIKIS

Differently from the observation of face-to-face interactions, the investigation of on-line communication dynamics focused on the use of text, images and layouts as relevant modes of communication for this research. This shift required a set of different methods to elicit data from an on-line environment, including a constant monitoring of the Wiki sites built by various groups of students at the Liverpool School of Architecture (Figure 3.5). A noteworthy similarity with the previously mentioned research methods is, however, the coincidental use of additional enquiry techniques to grasp a broad picture of the observed design studio, therefore allowing a more comprehensive understanding of the students’ activities as an interpretative context for the theory construction. As a result, in addition to the collection of information directly from the Wiki sites, semi-structured interviews have been conducted in order to better depict students’ backgrounds and insights about the use of Wikis. The full questionnaire can be seen in **Appendix IV**.

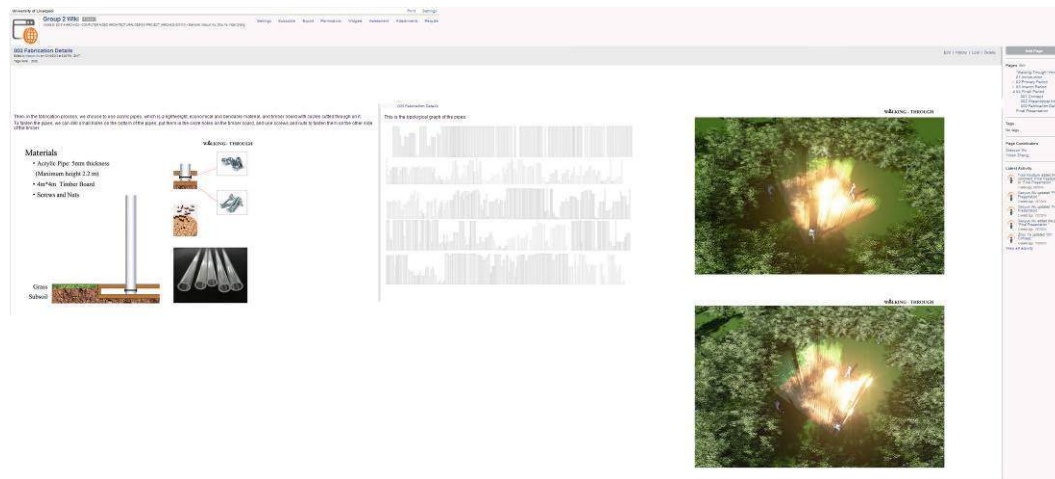


Figure 3.5. Sample Wiki site screenshot (Group 2). From left to right: a description of a building detail and materials, cutting patterns of the elements of the pavillion, renders of the finished pavillion. Source: University of Liverpool Blackboard system (2014).

The studio in which on-line communication was observed is a MA Architecture course comprised of 36 students from different international backgrounds. An aim of the studio is to broaden the designers' technology skillbase by making use of digital modelling and representation technologies. In that sense, the design brief is a rather small project for the design of a pavillion in the campus of the University of Liverpool. This simple brief allows students to leave aside some of the complexities of larger architectural projects, and therefore allowing more time for students to learn and apply the use of different digital tools for design, such as the parametric design engine Grasshopper. For this task, students were organised into groups of three members each, and roles were assigned to each student: architectural designer, manufacturing consultant and knowledge manager. The role of the knowledge manager includes the overall organisation of the working dynamics and among its tasks is that of updating the Wiki sites.

3.5.1. Observing communication in on-line environments

Despite this given organisation in groups, Wiki sites have been built in various ways and included not only a record of the design work to be shown to instructors, but also records of the group communications and scanned minuted of the group meetings (Figure 3.6). Relevantly, however, students declared that the main use of Wikis was that of communication with the design instructors by curating and displaying representations of their design progress.

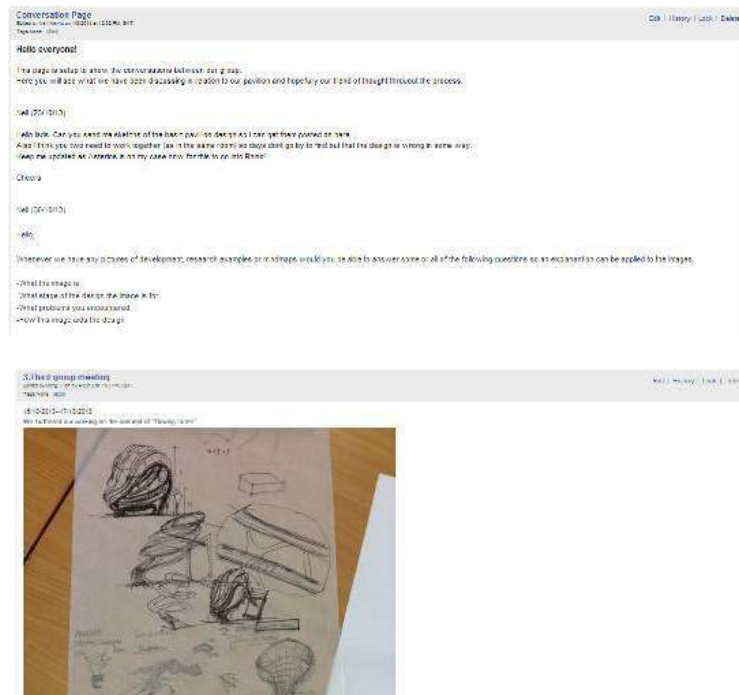


Figure 3.6. Wiki site screenshots (Group 1). Top image: Record of the e-mail communications across members of the group. Bottom image: Scanned record of the group sketching meetings. Source: University of Liverpool Blackboard system (2014).

On-line interactions are asynchronous in nature, and more similar to a message forum rather than a real-time synchronic conversation. The observation of the communication dynamics used in the Wikis sites, then, required a constant monitoring of the students' work as updates were constantly being made throughout the semester and outside teaching hours. Figure 3.7 shows the use of Wiki sites, by mapping all the comments in the message forums according to its day and time of publication. This view of the comments submitted throughout the course shows how frequently the studio community interacted through the Wikis outside teaching hours. Updates were usually made on a weekly basis and included records of students' meetings, records of their design work, as well as material related to their own individual software training with packages such as Rhinoceros and Grasshopper for parametric modelling.

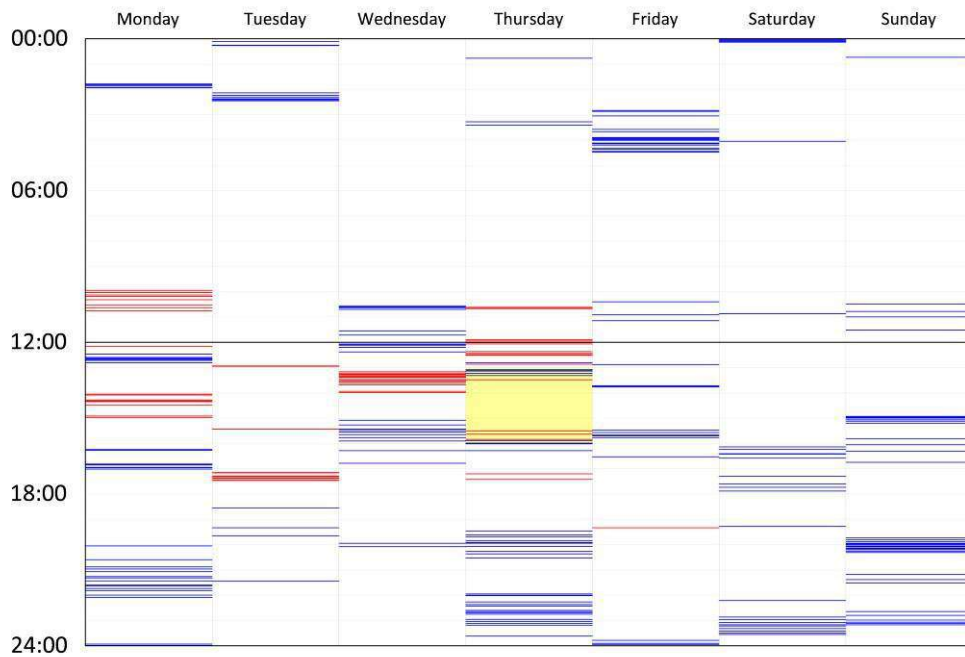


Figure 3.7. Schedule displaying the time/day of different comments made in the Wiki sites throughout the semester. The studio teaching time is highlighted in yellow, instructors' comments in red and students' comments in blue. Source: Kocaturk et al, 2014.

3.5.2. Collection of Wiki sites' modes of communication

Archiving the observed modes of communication was a process that entailed the use of screenshots and representations utilised by students to display their work. Differently from the recorded face-to-face interactions which required a transcription of the modes of communication found in the video records, the collection of Wiki sites and the students' use of text, images and layouts followed a rather straightforward collection strategy, by selecting and capturing relevant Wiki elements from the students' work (Figure 3.8).

University of Liverpool
Group 2 Wiki

003 Fabrication Details

Text (as heading)

Then, in the fabrication process, we choose to use acrylic pipes, which is a lightweight, economical and bendable material, and timber board with circles cutted through on it. To fasten the pipes, we can drill small holes on the bottom of the pipes, put them in the circle holes on the timber board, and use screws and nuts to fasten them on the other side of the timber.

Materials

- Acrylic Pipe: 5mm thickness (Maximum height 2.2 m)
- 4m*4m Timber Board
- Screws and Nuts

Image (building details)

Grass
Subsoil

WALKING-THROUGH

Text (as description)

Image (fabrication patterns)

WALKING-THROUGH

Images (project visualisations)

WALKING-THROUGH

Text (as message forum)

Viewer Comments (0)

Add a comment

Close commenting

Viewed 27 times

Pages

- 01 Introduction
- 02 Primary Period
- 03 Interim Period
- 04 Final Period
- 001 Context
- 002 Sketchbook Model
- 003 Fabrication Details
- Final Presentation

Tags

No tags

Page Contributors

Xiaoyun Wu
Yiyan Zhang

Latest Activity

- Tate Houghton added the comment "Final Feedback" to "Final Presentation"
- 2 weeks ago, 10/10/2014
- Xiaoyun Wu updated "Final Presentation"
- 2 weeks ago, 10/10/2014
- Xiaoyun Wu added the page "Final Presentation"
- 2 weeks ago, 10/10/2014
- Zhou Ya updated "001 Context"
- 4 weeks ago, 1/10/2014

View all activity

Figure 3.8. Identification of the roles of texts and images within the layout of a Wiki site.

Source: University of Liverpool Blackboard system (2014).

3.5.3. Students' semi-structured interviews

Similarly to the observation of face-to-face interactions, a series of semi-structured interviews were conducted at this stage of the research. These records are here used as a resource to situate the students' communication dynamics within their group work and for such purpose, interviews were organised both individually and with groups. Overall, 10 interviews were conducted (3 with groups and 7 individual interviews) with the participation of 15 students.

In regards to the collection of information from the Wiki sites, students confirmed that they make use of various communication media throughout their design process, such as social media and chat applications (Figure 3.9). Their design work involves a wide array of ICT tools to communicate and interact outside teaching hours, and as a result the information provided by Wikis does not fully represent their communication dynamics. Instead, a complex socio-technical environment that comprises social media and design representation tools is utilised throughout the design process.

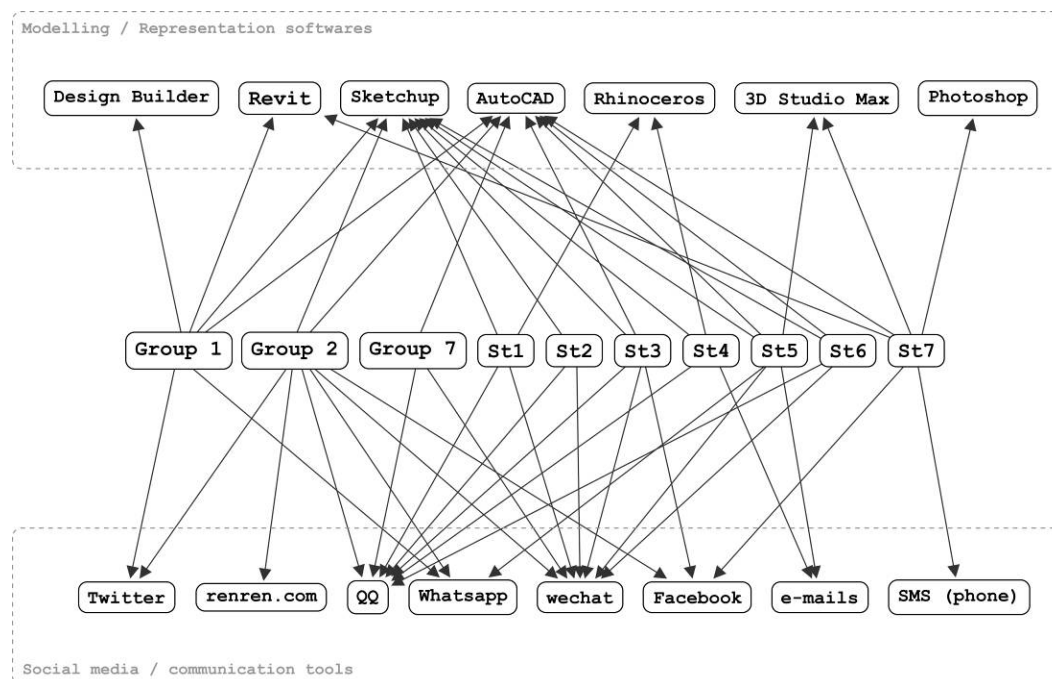


Figure 3.9. Array of representation and communication tools declared to be used by students throughout their design process. Source: Kocaturk et al, 2014.

3.6. INVESTIGATING INSTRUCTORS' PERSPECTIVES

The last stage of this research comprised the exploration of applicability boundaries of the theory of augmented pedagogies. Despite grounded theory produces outputs that are inherently linked to the contexts they arise from, this further exploration aimed to describe individual instructors' teaching approaches that might condition the use of the theory arising from this work. For this purpose, the enquiry was focused on their own teaching approaches, as well as their understanding and stances towards technology-enhanced learning in design studio courses. This method allows the construction of different teaching scenarios in which the theory can be applied, and the discovery of correlations across the components of the theory. Also importantly, it allowed the discovery of dimensions of technology-mediated teaching that are often unobserved by design instructors.

The information obtained from the interviews was also verified using participant observations, and as the same as the previous interviews conducted for this research, they followed a semi-structured approach. This allows to focus the conversation in specific topics whilst still providing room to further enquiry emergent relevant pieces of information provided by the instructors.

3.6.1. Instructors' semi-structured interviews

All the dialogues were recorded by the end of the academic year 2012-2013, with four different design instructors selected from different programs across the Liverpool School of Architecture, from different professional backgrounds and areas of expertise (i.e. digital design, professional practice and outreach, building technologies and restoration of historical buildings). Following a similar approach to the previously described methods, the information contained in the interviews does not attempt to generalise the behaviour of design instructors, let alone to expand the theory outcomes to a more generic level. Instead, this information provides insights to outline and describe potential applications of the theory in order to better understand and describe diverse teaching approaches. A record of the interviews questionnaire can be seen in **Appendix VI**, and the results of its analysis are described in detail in **Chapter 6**.

3.6.2. Participant observations

In addition to the interviews, observations were made throughout different studio courses and final submissions at the Liverpool School of Architecture. Regardless the fact that this research was conducted in the same School of Architecture, observations allowed a deeper comprehension of the existing teaching and learning dynamics and the use of representational tools by students, particularly during design critique session in a MA Architecture design studio course, and MArch (Master in Architecture) design jury sessions.

3.7. RECOMMENDATIONS AND REFLECTIONS FOR DATA COLLECTION IN THE DESIGN STUDIO

This research has comprised an intensive schedule of ethnographic work across several contexts of design studio education. While this fits with the requirements for the construction of a grounded theory (Glaser & Strauss, 1967) a series of ethical, analytical, practical and theoretical issues emerge when specifically investigating design studio settings. The methodological stance has been, however, developed over time, refined and formalised into a series of methods throughout the research process, turning the use of methods as a reflective and analytical resource for research. There has been a learning process that unfolded throughout three years in order to access and record the field, in which an increasingly refined theoretical sensitivity (Glaser & Strauss, 1967) has been developed in regards to “what to look at”, and how to record and interpret those relevant incidents. Such expertise resulted on a series of reflections and recommendations for fieldwork in design studio settings - a series of unwritten pieces of operational knowledge that underpinned the role of the researcher in the field.

Recalling the introduction of this Chapter, it is relevant to highlight the relevance and impact of each method in relation to the obtention of “data”. While video recordings and Wikis’ monitoring have been considered as the core data sources for the theory construction process, additional methods have been utilised to scaffold such techniques, providing further insights to support the interpretation and understanding of the observed design studios. In that sense, methods are not uniformly spread across the research process but instead each method fits within an intended scale, relevance and role in terms of fieldwork planning and data quality

assurance.

3.7.1. The observer / instructor dichotomy

When participating in the field (both figuratively and literally) the role of the observer was that of a design instructor, therefore a participant of the actions being recorded. While this stance is supported by existing literature on ethnographic research, what is gained from this account is relevant operational knowledge about how the researcher can operate in the context of design studio settings. In that sense, previous knowledge about how studios work, its cultural conventions and its corresponding social dynamics have been particularly useful after 8 years of teaching experience. Such knowledge shaped the way interviews have been conducted, and how observational work and recordings can be made. This is aligned with previous research in the field, as most of the previous works that observe design as interaction reported in **Chapter 2**, have been conducted by experienced design instructors as researchers. As a result, the participant observer is traditionally considered a “member of the academic community” conducting an informed ethnography, instead of a stranger (“marginal native” as described by Freilich, 1970) in the field.

The role of the participant observer has been discussed not only in terms of interference with the observed social fabric, but also on the accounts for data construction and transcription. The rethorics and representations of ethnographic texts lie on the assumption that there is no possible way to fully depict and represent the observed social phenomena. In that sense, a previous rationale about the specific modes of communication observed for the purpose of this research, embedded within a known cultural context, was of utmost importance and usefulness to keep moving through the research process. This focus on the semiotics of the social setting has been highlighted even prior to the development of multimodality as a research approach, as declared by Atkinson & Hammersley (1994),

An emphasis on semiotics ... has informed ethnographic data collection and analysis. Here an attention to culture as a system of signs and texts provides the major impetus. In ethnography the textual metaphor of culture has found its major proponent in Geertz (1973), whose formulation of “thick description” stresses the interpretation of cultural meaning (p. 258).

3.7.2. Transcribing multimodal face-to-face communication

The core aim of fieldwork is to collect relevant data for the purpose of the research question. Data, however, requires a construction process that translates the relevant incidents and pieces of information - regardless their original nature - into a format that allows a comparative analysis. In the literature, elaborated transcription systems can be found to represent monomodal data, such as sophisticated codes to transcribe speech (including symbols to represent intonations, pauses or overlaps between speakers) or graphic systems to represent gestural communication. Multimodal transcriptions, however, pose the challenge to represent coordinated modes of communication occurring synchronically. Text and images operate at the same given time within Wiki sites, and likewise speech, gestures and actions upon models operate in an orchestrated manner throughout face-to-face communication.

The construction of the data transcripts, then, requires a rather intensive work of translation of such modes of communication into formats able to be comparatively analysed, leaving aside unwanted information yet keeping the integrity of the observed social fabric and its modal assemblies. Such filtering and accommodation process across different layers in the data tells about what is considered relevant, and how such incidents are furtherly identified, coded and compared to each other throughout the theory construction. As a result, and aligned with the suggestions from Glaser & Strauss (1967), the comparative analysis between incidents is not a separate stage of the research, but is instead developed as a continuous reflective process as the research proceeds.

In the case of video transcripts, data has been represented considering gestural communication, speech and use and actions upon augmented models. Such contents are organised into data transcripts as follows:

Representing speech as text

A text-based account for the transcribed dialogues is included in the data. As known in the social sciences, representing speech in data transcripts follows a series of notations to support the representation of the modal resources involved in spoken communication: pitch, emphasis, pauses or intonations, among others. The most common notational conventions are those developed by Gail Jefferson on a series of publications and compiled in detail by Atkinson & Heritage (1984). In this

research, a simplified notation based on Jefferson's system is used to transcribe speech detailed in Table 3.1.

Table 3.1. Table indicating the transcription notations used in data transcriptions.

Notation	Description
(.)	Short pause during speech, during or between utterances.
(8)	Pause of 8 seconds during speech.
(-)	Speech not clear enough for transcription.
(text)	Not fully clear speech, yet recognisable for transcription. Jefferson describes this text as “especially dubious” (2004).
((text))	Indicates comments from the transcriber.
[text]	Indicates overlapping speeches.
{ text }	Indicates an action being detailed in a video screenshot.

Representing actions upon models as images

Actions and relevant physical interactions not able to be described as part of the speech are illustrated with images obtained from screenshots of relevant video frames. The simplification of a video (as a collection of sequential frames) to a reduced selection of relevant-only frames implies some loss of information. For this reason videos are still constantly being used to verify gestural sequences, temporal properties or its intermodal relation with speech.

Representing gestures as text

Finally, gestural communication is described as text-based information supporting both speech transcripts and images. Gestural communication is not detailed on its physical dimensions (extension of hands, length or duration) as it relies on the supporting images and video records during comparative analysis. Yet, it is written next to its corresponding speech transcription to keep a record of the temporal relations between spoken and gestural communication. Figure 3.10 shows a sample data transcript that combines the aforementioned multimodal account of the AR-mediated interactions.

Group 2 – AR-based dialog 1 (00:03:34)







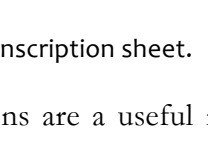
	Dialog	Gestures	{Screenshot}
	---Beginning of the dialog---	This dialog is the beginning of a design critique for the group 2. Is focused on the setup of the AR models on the screen and how the technology operates.	 
I1	Yes yes yes yes (.) wait wait		
S1	(-) is going well, a (red model) [I1: ok, ok] (-)		
S2	(let's see)	Both student and instructors are {watching at the AR model} in a laptop screen {held by S2}.	 
S1	move it a bit		
I1	excuse me		
S1	yes (9)	I1 takes the marker and starts moving it, {overlapping} the 3D model with the {printed floorplan}. S2 tries to {modify the AR scene} in order to improve the visualization of the 3D model. During the pause (9) students mix several spare words (not audible due to overlaps) to make fun of the situation of holding the laptop to visualize the model properly.	 
I2	you know, that you can eventually use a webcam?		
S1	eh		
I2	so you don't need to	"eh" in approval tone.	
S2	yes		
I1	you have to (-) so the model {fits} (.) good (10)		

Figure 3.10. Sample data transcription sheet.

In multimodal research, tailored transcriptions are a useful resource to depict, represent, record and elicit relevant information from the data. Interesting examples can be reviewed in the Transcription Bank created by the node of the National Centre of Research Methods “MODE: Multimodal Methodologies for Researching Digital Data and Environments” (MODE, 2014). It must be remarked, however, that there are additional modes of communication and detailed modal resources being purposefully ignored in the transcripts utilised for this research. For instance, intonation and pitch as modal resources have been left aside due to the translation of dialogues from Italian to English. Likewise, environmental conditions, which might have a limited incidence into the communication dynamics, are not fully accounted for (lighting conditions, background noise, among others).

3.7.3. Transcribing multimodal online communication using Wikis

The archived modes of communication follow a rather conventional set of uses and organisations when compared to blogs and other authoring on-line environments. Recalling **Chapter 2**, however, there are few accounts of how text and images are assembled in on-line environments into meaningful layouts. Even though a locational criteria for text in relation to image can immediately depict some descriptive assembly (e.g. an image captions), those configurations are reported in more detail by Unsworth & Cleirigh (2009). Some of the possible relationships across texts and images are those of the description of qualities, the description of

components, or the description of locations of different elements in the image (Unsworth & Cleirigh, 2009). As described by Kress & van Leeuwen (1996), such modal configurations foster a functional role of the different identified modes and then resulting into meaningful layouts and reading paths.

Additionally, in regard to the different representations students use to display their design process there is an alignment with the observations made by Unsworth & Cleirigh (2009). They state that when images require further explanatory supplements, text helps the reader to visualise the content as intended by the author rather than leaving such meaning-making task to the reader's interpretation. This authoring resource is present in students' Wikis, as they tend to display various modes of representation (different types of images, such as building details, 3D visualisations and sketches) when required, supporting such ideas with texts. Such way of representing design knowledge tells about the way students relate to the reader - and in some cases, it was explicitly confirmed by students on their communications copied in the Wiki sites (Figure 3.11).

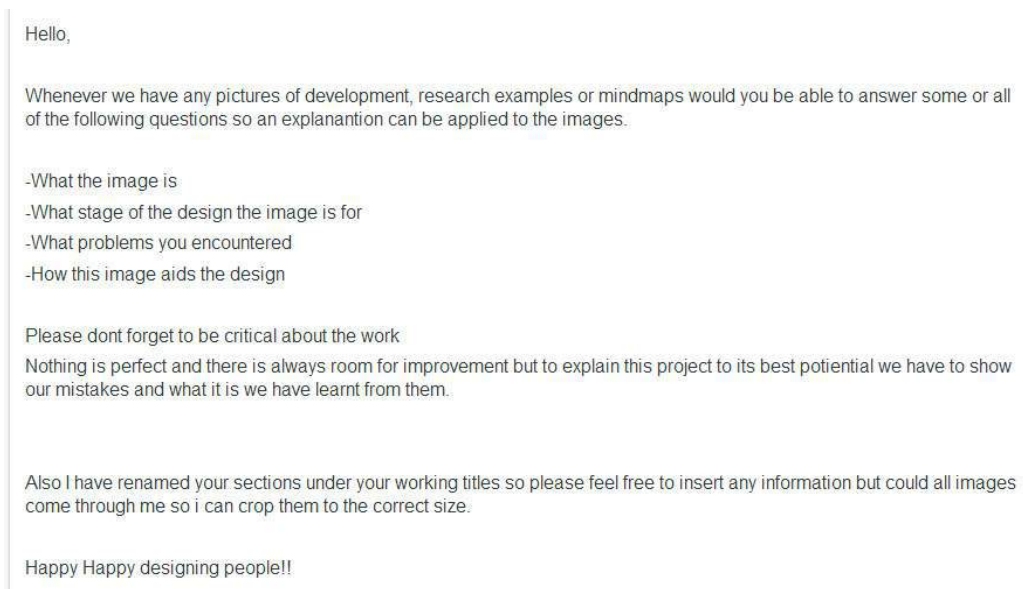


Figure 3.11. Extract of a communication Wiki site (Group 1). Source: University of Liverpool Blackboard system (2014).

3.8. SUMMARY AND CONCLUSIONS

This Chapter draws upon a series of research methods and techniques to conduct

fieldwork research. More specifically, it has addressed a series of methods targeting the identification and collection of the relevant modes of interaction to be analysed for the purpose of this work. The core two contexts in which data is collected are those of face-to-face interactions in the design studio during design critique sessions using AR models, and on-line communication across the studio community using Wikis. Additional research methods have been proposed as a mean to reinforce the quality and integrity of the collected data: supporting methods to situate the data in context, or exploratory workshops to verify the affordances of AR technology in design studio settings.

The collection of methods follows the steps taken in this research process, and each setting and its corresponding theoretical requirements shapes the methodological rationale accordingly. As intended and despite the fact that no methodological stance can fully reflect the dynamics of the observed settings, this methodological frame follows the suggestions and recommendations drawn by previous ethnographic work in educational contexts, and fits within currently utilised multimodal research techniques. Additionally, methods have been selected and tailored to fit within the cultural and ethical requirements posed by design studio courses.

As a result, this methodological stance complies with the objective 2 of this research, that of developing **a multimodal research approach and its corresponding methods and tools for architectural education research**. In conclusion, this methodological stance has followed precepts of various interrelated ethnographic techniques on an attempt to build a “cognitive ethnography” of the observed field by matching experimental and ethnographic procedures. Such theory construction process is presented in the following Chapters.

CHAPTER IV

**CONSTRUCTION OF
CONCEPTUAL CATEGORIES:
ANALYSIS OF FACE-TO-FACE
INTERACTIONS DURING DESIGN
CRITIQUE SESSIONS**

4.1. INTRODUCTION

This Chapter reports on the construction process of a conceptual vocabulary, the initial theory output of this research. The conceptual vocabulary shown here has been obtained from the detailed descriptions of the impacts of augmented reality (AR) technologies in the context of various design studios' critique sessions, categorised into a set of core concepts - the initial building blocks of the **theory of augmented pedagogies**. Following the previously developed theoretical and methodological foundations described in **Chapters 2 and 3**, the focus of enquiry is put onto the detailed dissection of the intermodal nature of the design critique dialogues, which assembles the use of speech, gestures and actions upon models.

The observation of design critique sessions has been conducted during fieldwork at the Polytechnic of Turin throughout 3 weeks of observational work, software tutoring and design studio teaching with 2 groups of undergraduate (3rd year) Architecture students. Once identified, relevant incidents have been elicited from the recorded data and organised into conceptual categories, after a selection, transcription and theoretical coding process. This procedure has resulted in a series of conceptual categories that account for the impacts of AR in design dialogues. After these categories are described, a secondary analysis using video coding provides clues to better comprehend the patterns of communication that can be found in design critique sessions. Finally, conclusions are drawn upon the processes of coding and comparative analysis, their fitness for grounded theory research and the compliance between the outputs of this stage of the research, and the research objectives.

4.1.1. The communication dynamics of a design critique session

The design critique is the main acculturation activity where instructors and students engage into a dialogue that leads to new design insights, knowledge transfer and ideas. As already reviewed, the design critique dialogues are mediated by the use of speech, gestures and models that represent design ideas and information, and mediate the communication between members of the studio community. Given that this Chapter focuses on the analysis of design critique sessions, this Section highlights the core features of such institution in design studio teaching. Both physical and digital techniques are widely used by students to

construct models and to embed different types of design knowledge into an array of representational methods, each with their corresponding modal resources. How that interaction occurs and how the integration of AR shapes the design critique sessions are the questions this Chapter pursues to answer.

Instructor-learner interactions are defined by the processes in which knowledge is delivered and acquired on the studio's teaching-learning scheme through different combinations of speech, gestural work and representations, and is usually expressed on design critiques and design jury sessions. Different interactions and influences within design settings have been the subject of diverse and well documented research, since the design critique is one of the key "rituals" in design education, which still remains as a reminiscence of the classic master-apprentice scheme. Murphy (2004) explains how ideas emerge from a group of people who use many semiotic media available to them in their social surround to "imagine something together". He points out that understanding design as a situated activity poses an advantageous research strategy, since we cannot access the "cognitive machinery" of each participant.

As a result we can investigate this learning process by using tools such as the observation of their engagement with collaborative activities and representations such as gestures, talks and objects. Similarly to Murphy (2004), the more recent work by Luck (2009) also attempts to explain design interactions and specifically the evolution of a design concept during a design review. On a similar methodological standpoint, he observes communication between the architect and a client using conversations and representations. Then, authors coincide on the understanding of the design critique session as an effective context to observe design interactions, which includes complex assemblies across dialogical, organisational and cognitive components.

Regardless of the mentioned approaches to the description of the design critique, the interactions shaping the design critique in educational contexts are hardly defined. This, because student-instructor interactions are usually a response to specific design problems and guidance required by students on an individual basis, by following an array of accordingly sequenced teaching methods (client-based scenarios, consultant-based scenarios, expert and novice designer scenarios, and so on). This individual nature of the design critique is highlighted by Webster

(2008) who points out that, according to her research on the subject

The findings built a picture of the architectural review as an important symbolic ritual in which 'apprentices' (students) repeatedly present their habitus, a notion of identity that includes cognitive and embodied aspects, to their 'masters' (tutors) for legitimization. (p 265)

In that sense, even if some previous work can be related to the overall description of design critique sessions (Oh et al., 2014), their hard replicability across diverse design scenarios remain as a challenging task for architectural education research. Aligned to this view and according to Ochsner's analysis of the studio interactions (2000), instructional relationships have been hardly studied on the 'learning by doing' educational era.

On a more recent study, Goldschmidt, Holdman & Daphni (2010) define the studio critique session as a 'one-to-one desk critique in which student and teacher discuss the student's work in progress on a regular and frequent basis' (p. 285). Agreeing with Ochsner's standpoint (2000) they propose that the nature of the design critique arises as an emergent phenomena, explained on their conclusions as 'far beyond sharing knowledge with students regarding the subject matter of the project, the teacher must navigate among categorical action priorities that suit the student's need and his or her own tendencies' (p. 300).

Even though there is no possible generalisation or metrics to assess the design studio critique, the study of Oh et al. (2012) coincides with Goldschmidt et al. (2010) regarding the validity of best practices and the importance of previous design expertise of the studio instructor. The role of representational technologies in design critiques is also matter of research reported by Oh et al. (2012), however they focus their analysis on the use of IT communication technologies to provide feedback and contents rather than in the instructor-learner interaction via representations and models.

As a result it can be argued that the construction of a theory framework that describes AR-mediated design critiques demands to carefully account for exceptionalities and commonalities throughout the comparative analyses - while there is some common ground from which a design critique can be described, it's a highly context-dependant and situated activity.

4.1.2. Design critiques' selection for data analysis

After filtering and reviewing video recordings and semi-structured interviews, relevant slices of data have been selected to ground the conceptual vocabulary. Such pieces of information have been chosen due to their high density of communication patterns, the use of AR tools during design critique dialogues, and its variability in terms of groups of students and design projects. Using video editing techniques, such slices of the video recordings have been isolated for a more detailed analysis, with a total of 10 minutes of dialogical feedback sessions with 3 different groups of students. Considering detailed behavioural patterns with a rather short lifespan, such as gestural actions, 10 minutes is a slice of data with a rather high density of incidents to be codified, therefore contributing with a large amount of information for the purpose of this research.

4.1.3. Face-to-face multimodal interaction: exemplary dialogues among participants

The observed studio is led by Alberto (I1 in the data transcripts), and his teaching assistant Dante (I2 in the data transcripts - names have been modified). The studio is notably large: 70 students. Even if all students are not in the room at the same time, the environment comprises a high density of peripheral activity - most likely due to the upcoming submission deadlines. Several students go in and out in an uncontrolled manner and instructors do not seem to care, as they focus their attention onto the design critique sessions with groups of students at their desk.

Alberto is a young lecturer (*Professore Agreggato* at the moment of writing this dissertation, according to the Italian academic scale) who according to students seems to balance quite efficiently a constructive dialogue with students, together with a strong and explicit guidance in terms of design work, modelling and further design moves. His feedback seems to be rather unstructured, design critiques have several interruptions, overlaps of speech and gestural communication and yet, students seem to be satisfied with his expert role. Dante, on the other hand, seems to be a more passive observer of the critiques. He speaks little, mostly about software use and representations, and seems to be not only contributing as a teaching assistant but he is also “learning the craft” of studio teaching from

Alberto.

This contrasting difference between their personalities, however, proved to be rather relevant for data collection, as they result in different behavioural and communication patterns with students. This is confirmed by previous research investigating the teaching approaches of different design instructors such as the ones conducted by Simmonds (1978) or Mewburn (2011). While Alberto has been more actively engaged in an interaction with students using and drawing models, Dante usually had a more passive role observing Alberto's speech. As a result, several relevant gestures and interactions with the models could be observed from Dante's participation, yet he still performed some individual interactions with the utilised media. While some can be labelled as “**manipulating models**” for the sake of curiosity or novelty, other interactions had a further impact on the design critique.

For instance, an interesting situation that illustrates the shifts across instructional roles occurred during a design critique with the second group of students (Group 2). By using cardboard, students created a small 1:500 urban model with interchangeable AR markers to display different design alternatives on screen (Figure 4.1a). At first, instructors seemed surprised and playful with their submission:

I1: Ah another marker,

[S1: Yes] can we use this?

They spent some time manipulating the models on screen (Figure 4.1b) and seemed to feel happy to count with an interchangeable set of AR-based design alternatives:

I1: well done adding this cardboard slip

At this point, the dialogue seems to be more focused on the construction of the model itself, instead of the design information being represented - a dialogue about the effects *of* technology rather than about the effects *with* technology in their design (Salomon, Perkins & Globerson, 1991). Positive intonations of voice can be identified in the video records and overall, the conversation seemed to be positively interpreted by students, who were satisfied with their submitted materials. In addition to the physical model, they also presented a digital massing model on the

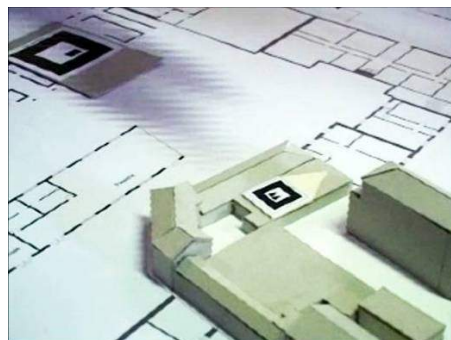
top of a floor plan layout. This marker is visible on the top left corner of Figure 4.1a. After some seconds visualising the AR model, Alberto shifts the conversation towards more “designerly” topics. For manipulation purposes, he leaves the model in the table switching from an AR to an entirely physical representation, a floor plan (Figure 4.1c), by indicating it and asking the students about a particular feature of their design

I1: How did you create this kind of hallway (2) free of any shelter?

Here, the instructors’ roles shift. During a short period of one minute, Alberto enquires about the architectural program distribution in their floor plan:

I1: I understand little, for example, of how the (-) program was redistributed (.) this part here, very wide and (-) shelter

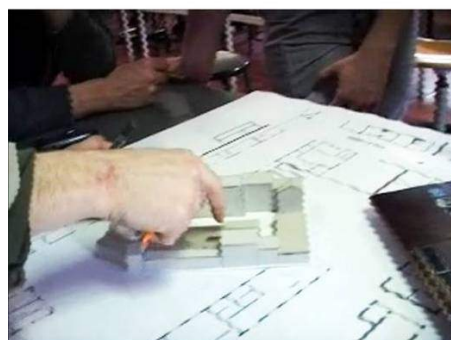
In the meantime, Dante keeps moving the markers on screen, exploring the AR model on what seems to be a rather silent **curiosity-driven manipulation** rather than a more detailed observation of the design alternatives (Figure 4.1d).



(a)



(b)



(c)



(d)

Figure 4.1. Video frames illustrating the different instructors’ roles uses of an AR model during a design critique session.

A fairly large density of relevant incidents can be recalled from his situation. Individual user-driven manipulations, overlays between physical and digital models, a switch from a AR to a physical representation, or positive attitudes towards the AR models are among the possible ways in which data can be observed, compared and conceptualised by identifying such incidents and their multimodal construction based on speech, gestures and actions upon models. Such process, named conceptual derivation, is the foundational step to develop a vocabulary that accounts for these complex interactions and is the locus of the following Section.

4.2. CONCEPTUAL DERIVATION: NAMING AND CODING INCIDENTS THROUGH COMPARATIVE ANALYSIS

4.2.1. A multimodal description of relevant incidents

The following extract stresses the need to account for the multimodal construction of the AR-mediated dialogues. In that sense, the observation of gestural communication and actions upon models have proven effective means to understand the actions and unravel its design dynamics.

Take, for instance, the following “AR-based dialogue 1” between the instructors and Group 2 (**in full in Appendix I**). This dialogue was conducted at the beginning of a design critique session. After the technology tutorials, this was the first design critique for this Group making use of AR models. Students begin by holding a laptop in the air in order to point towards the AR marker and display the model on screen. The conversation unfolds as follows:

I1 yes yes yes yes (.) wait wait
S1 (-) is going well, a (red model) (-)
[I1: ok ok]
S2 (let's see)
S1 move it a bit
I1 excuse me
S1 yes (9)

For a reader unfamiliarised with the data and its context, not much can be inferred from this dialogue. It is possible to hardly state that something “*is going well*” and that it might be referring to a red model. Then, Student 1 (S1) asks

somebody to “*move it a bit*” without any noun accompanying such action, and as a consequence it is not possible to fully picture what is going on during the “move”. Additionally, it is not possible to understand why Alberto (I1) is excusing himself, or why is there a pause of 9 seconds after the student’s approval at the end of the extract. It can be fairly stated that this dialogue can be hardly analysed and described in terms of actions and incidents, and even less information can be elicited in terms of the role of AR models in the teaching and learning modes, and the multimodal construction of the actions. Short sentences and the lack of a grammatical subject upon which actions are performed configure a linguistic structure that does not conform any requirement for further interpretation or even worse, leaves interpretation and description as a task based on hunches and researcher biases rather than descriptive and accurate analytical material.

Nevertheless, additional modes of interaction can provide further details of the meaning of this sequence. As previously stated, meaning making then turns into a critical action of data recording and transcription. Different modes of interaction do not only support the linguistics of speech, but also instead assemble different modes of interaction (speech included) in order to accurately describe the social setting and make sense of the ongoing situations (Streeck, Curtis & LeBaron, 2011; Kress, 2010).

A detailed observation of the video records indicate that the first sentence from Alberto, “*yes yes yes yes (.) wait wait*” is referred to the students displaying the AR model on screen (Figure 4.2a), as he wants to quietly observe the model on screen. He says this while watching at the screen being held by one of the students (Figure 4.2b), and asks them to “*wait*” telling them to stop moving the model around the screen to see it properly. While they watch this, a student says that the red model “*is going well*” pointing at it, so the instructor ask the students to move the marker in the space to check if the tracking system works accurately, fitting the digital model on the top of its physical counterpart (Figure 4.2c).

The digital model corresponds to a massing 3D representation, and the physical model is a printed floor plan above which the massing model can be seen (Figure 4.2d). At this point, the marker is on the table surface, and Alberto excuses himself (“*excuse me*”) so he can pick it and manipulate the model on screen, while the students still hold the laptop in front of him. Then the final pause of 9 seconds is

intended to give time to Alberto to move and visualise the marker at will. As seen, this conversation contains a series of incidents such as individual manipulation of models, organisational shifts, or gestural actions. All the actions mentioned here take place in 27 seconds of video recordings, and would be hardly expressed, transcribed and analysed by making use of solely using conversational text-based transcripts.

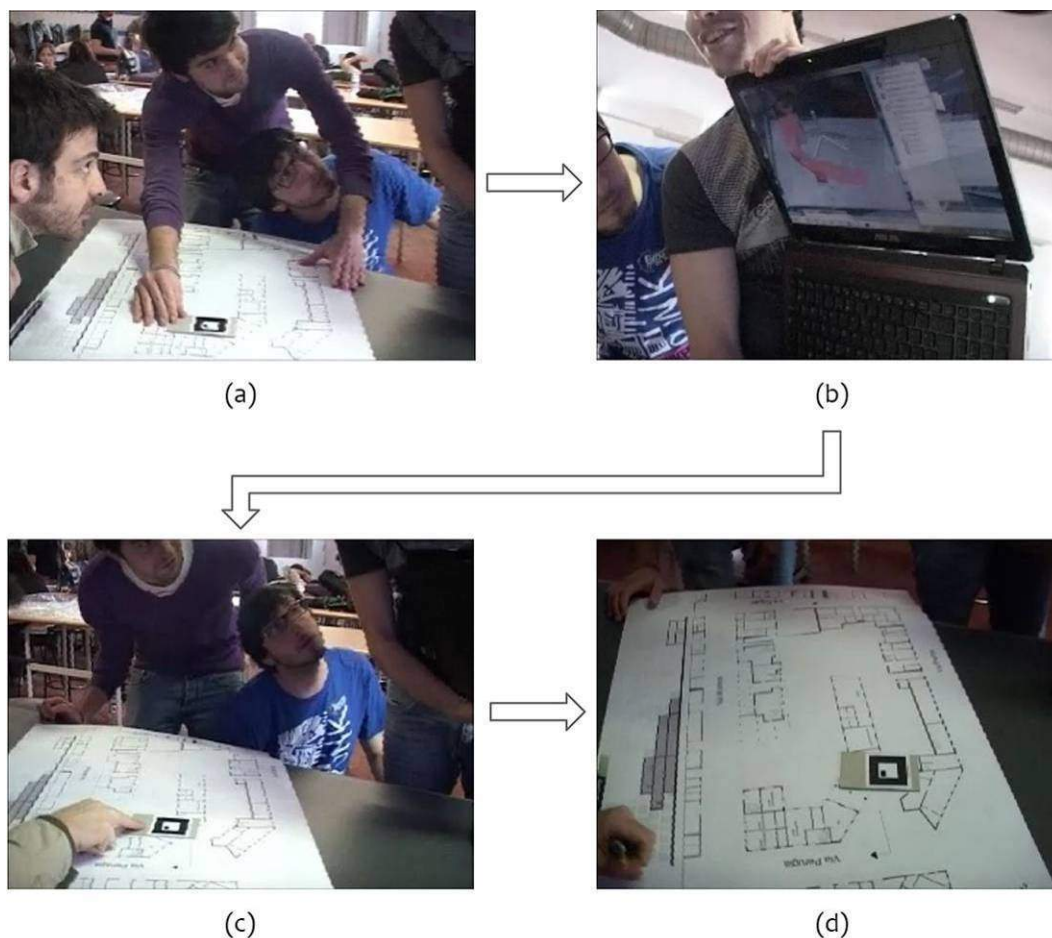


Figure 4.2. Video frames relevant to describe the interaction between a group of students and instructor, sequenced indicated in the text (a, b, c, d).

4.2.2. Naming and coding relevant incidents

The previously mentioned sample dialogues illustrated by Figures 4.1 and 4.2 accounted for the multimodal nature of the design critique dialogues, and provided an illustration to better explain the rationale and construction method for the data

transcripts while keeping the multimodal integrity of the data sources. Grounded theory relies upon the comparative analyses of evidence to build a theory directly from the data it comes from (Glaser & Strauss, 1967).

The process that structures such comparative analysis is coding, which is defined by a series of steps to transit from the raw data into theoretical labels, categories and concepts. The first step in coding is that of open coding. Open coding proceeds by labelling relevant incidents and naming them accordingly and serves as a first, initial glimpse to the data. Open coding entails the elicitation of “basic themes” out of the data, telling us “what the data is about” (Charmaz, 2006).

Appendix III includes a transcription of the video records, as well as a detailed separation of incidents and their initial coding and grouping into relevant categories. While this is a first step throughout this research process, the grouping of codes into categories is also indicated.

Some works can be found on using coding techniques in the construction of theories for architectural design education (e.g. Kocaturk, 2006). In this research the complexity of the studio system and the relations among instructors, students and models are depicted through codes, dissecting the data recursively until it is fully described using “basic themes”. Multimodal transcriptions add a layer of complexity to the coding process as some basic themes are depicted across different modes of interaction and are represented as images, gestures, speech or combinations of them. As such, the multi-layered and inter-modal nature of events also poses the challenge of delimiting certain conceptual labels to specific data bits such as text, comments or images.

Recalling as an illustration the previously mentioned sample conversations, it has been possible to observe that students display their AR model, but they forgot to use a webcam for visualisation purposes. As a provisional solution, a member of the group stands holding the laptop, while the integrated camera points towards the AR marker and the model can be seen on screen. As a result, the group of students now consider the role of the “laptop holder”, other student acts as the operator of the AR model whilst the third one explains Alberto and Dante what the model is about.

This specific incident has been labeled as a “**shift on the organisational setup**” of the critique, as it tells us about the roles within the group of students.

The role of the “laptop holder” is required to show the instructor the AR model, an action which occurred through the multimodal assembly across the emergent organisational setup of the design critique, the “speech” of the student and his “gesture” pointing at the screen indicating that the model *“is going well”*. Those two students participate in such situation while communicating that message to the instructor. This specific gesture has been considered as relevant, as it provides evidence of how **“students interact with the instructor through manipulating an AR model”**, by pointing at it - and has been coded accordingly. While this type of organisational shifts can be nonetheless found in diverse situations in design studio teaching, this specific incident is embedded into a series of associated and sometimes parallel incidents such as student-instructor interactions using AR technology, or gestural communication (e.g. pointing at a model). As a result, while organisational shifts can probably be commonly found in design studios, this specific category addresses the multimodal communication assemblies taking place in such shifts through the use of AR models.

Another incident within this short data sample is, likewise, relevant to this analysis. When the instructor excuses himself for holding the marker and becoming the “model operator”, there is a new shift on the roles within the design critique. The role originally assumed by the students presenting the work has been now shifted towards Alberto, and he excuses himself for that (*“excuse me”*). This incident marks also yet another **“shift in the organisational setup of the design critique”**, as the role of the “model operator” has switched between the group of students and Alberto. He can now manipulate the model and holds a higher degree of dexterity and power over the model being displayed on screen.

The incidents that tell us about the organisation of the design critique session in terms of roles, once compared, say different things about the changes on the organisational setup of the design critique. On such limited data bits it is already possible to induct that specific AR-enabled organisational shifts occur within the group of students, but also between students and instructors. Both changes are also task-oriented, as the changes on the different roles aim to clearly display the AR model on screen for different purposes - in both a descriptive manner by the students, and a more exploratory manner by the instructor. Those roles are specific to the use and operation of AR models, such as the manipulation of models or its

visualisation through a manipulation of screens and cameras.

The comparison across those two incidents, then, allows the creation of a provisional category to describe the data, which of the “**shifts in the organisational setup**” of the design critique session. This emergent category might be able to allocate further incidents applicable to the technology-mediated changes on the organisational setup. If so, the understanding and scope of this category is furtherly modified accordingly by adding new incidents and descriptors as the coding process proceeds, refining and strengthening the definition of such category on a continuous comparative analysis process. Ultimately, 64 incidents are identified in the video records, from which 7 conform the conceptual category “**emergent organisational shifts**”. As a result of this constant comparative analysis, 7 categories have emerged as a way to organise and formalise the description of AR-mediated design critique dialogues.

Varied recommendations can be found in the literature in order to conduct initial coding, such as “line by line” open coding (useful when only lines of speech are considered) or “word by word” coding (quite useful in condensed, short data sources such as social media). In this research the followed standpoint is that of “incident to incident”. Describing incidents is a coding strategy keen to be utilised with multimodal data transcriptions as is not constrained into certain data formats, and can afford to take into account different modes of data representation (Figure 4.3).

I3 (but) did you try it?	S2 checks in the screen the location of the model while S1 keeps holding the laptop. I3 question is referred to create an attempt of the AR model prior to the design critique.	<i>use of software</i>
S1 at some point we tried	<i>previous attitude towards AR</i>	
I1 well, a more or less, but we can see it (.) a model		
S3 but this is the model	I1 is still starting at the screen and now continues manipulating the marker around the printed floorplan. (S3 indicates) him where the 3D model is supposed to fit with the floorplan. (S2 places) the marker properly (in the floorplan).	
I1 as so if (fits) ok (S) at this point can you move it? (I mean, the point of view?)		
S1 yes, well	(S1 starts moving) the laptop in order to show the 3D model from a different perspective while still aligned with the floorplan.	
I1 I'm not moving the camera, do not do don't do it (now)		
I2 yes but you can just rotate the marker and move the marker around (.) if you want to see the building from	(I1 rotates the marker) in front of the camera.	<i>asking about navigation/rotation</i>
I1 yes yes but in relation to the plan (.) I was asking myself why it doesn't keep the position on the map (S2: is set about the quality of the model)	(I1 overlaps) the marker with the floorplan again.	<i>just digital</i>
I2 ah, it is very strange		<i>hybrid representation (analogy)</i>

Figure 4.3. Hand coding of transcribed data sheets.

4.3. DEFINING SETS OF RELEVANT THEMES

Following Glaser and Strauss' guidelines on grounded theory (1967), a constant comparative method proceeds as similar incidents are compared to each other, thus setting initial descriptors for its categorisation and organisation. As already stated, 7 categories have been built in order to describe how AR technology impacts upon the observed design critique sessions. Categories are elaborated via a combination of deductive and inductive reasoning, and the aim of this initial clustering of incidents is not to solely name those categories, but also to describe them on an early degree of depth. The 7 categories can be described as follows:

4.3.1. Solo interactions

This set of incidents is composed of 12 codes and is one of the most populated categories in the records. Individual interactions are here categorised as means to describe the situations in which a person manipulates/operates an AR model without the influence of any other participant of the communication dynamics. Interestingly, whilst design critique sessions are densely populated by communication patterns, there are still several recorded incidents in which members of the group interact with the AR models in isolation.

Not necessarily within a dialogue, incidents that compose this category show that users tend to make use of the AR model for observation, testing or curiosity-driven purposes. Such isolated activity, even if does not entail *per se* a social interaction across members of the studio community, showed a consistent presence throughout the data transcripts. Actions that were mostly performed during individual interactions are those of manipulation of the markers in front of the camera (similarly to the one shown in Figure 4.1d), students' display of AR models on screen before showing it to the instructor, and the instructor's visualisation of the AR models on a laptop screen.

Recurrently (in 7 out of 12 incidents) it is the instructor who manipulates the models as a way to explore the design work of students, action usually followed by questions or comments. Within the data sheets, such pauses for individual manipulation can be often found at the end of certain speech transcriptions. Usually those pauses take place when the instructors or students manipulate and test models, or reflect upon them in order to continue the conversation. It is

important to remark that during individual use of models, along with challenging the social nature of the design critique itself, there is usually no speech involved. As a result, this category could not be defined and formalised without the use of a multimodal account of the social interactions comprising gestural communication and actions upon models.

4.3.2. Social interactions

When compared to the previous category, a lower amount of incidents describe situations in which members of the dialogue interact with each other through the use of AR models (11 initial codes). Across the main actions upon the models are those of manipulation and pointing at them (Figure 4.4), and such actions are particularly relevant for a detailed analysis due to its social nature between students and instructors, and the use of models as a mean for such interaction.

Incidents grouped in this category are highly interweaved with those categorised as individual interactions but, however, are usually found in dialogues focused on design decision-making and feedback from instructors. This poses a different context of operation than solo interactions, usually focused on curiosity or novelty-driven exploration of AR models. For instance, the student pointing at the screen in Figure 4.4 (top left) explains to Alberto the spatial qualities of the square where the building is located. Other instance where this type of incidents can be found is when students and instructors engage in a dialogue about technology use or troubleshooting.

An early finding of this category is that students and instructors actually use AR models as a communication resource, and that this interaction considers both digital and the physical counterparts. Sometimes, digital images are visualised alongside physical representations in order to compare and contrast two different modes of communication (e.g. a massing model visualised on top of a floor plan) and therefore producing more interactive, content-rich architectural representations. Also, it is important to remark the similar nature of incidents that can be considered as conversations about design (such as decision-making), and conversations about technology (such as in troubleshooting advice). Shifts between those two types of dialogues take place in rather short slices of data with hardly defined temporal boundaries, yet still identifiable due to the gestural communication involved.



Figure 4.4. Video frames that show some interactions between people by using augmented models. Most of the actions in this category involve the use of AR on screen (for visualisation purposes) or pointing at it as a communication resource.

4.3.3. Technology affordances

In design, the “affordances of things” are usually related to their intended purpose (Moura, 2008), but in the context of this research the notion of “affordances” is more closely related to a definition more widely used in multimodal and cognitive research, that is “perceived and actual properties of a thing, primarily those functional properties that determine just how the thing could possibly be used” (Salomon, 1993).

This category comprises exclusively such incidents in which the affordances of AR technologies are mentioned or speculated – *what are its properties and what can users do with it?*. Incidents related to the use of technology cover a wide range of subjects that allow this category to identify and describe how students and instructors make use of AR models, ranging from digital and physical overlays throughout the design critique up to speculative applications mentioned during the dialogues.

An example of this type of incidents is the short sentence of Alberto in which

he strongly suggests the students how to use AR technologies to build a model

I1 ... for instance (.) I have a project's floorplan and a model of the full volume (-)(.)

Not surprisingly, this is the category that groups the highest amount of incidents (13). Usually communication referred to the use of technology by means of conversation or gestures were evident and yet, detached from any design-related sequence throughout the conversation. It cannot be discarded that many of the conversations about the uses and affordances of the technology are commonplace when infusing a new tool into the design studio.

4.3.4. Troubleshooting

Several incidents are referred to troubleshooting and solution of technical problems during the instruction and operation of AR technology. Being a category that still groups a significant series of initial codes (10 codes), it is relevant to address the challenges that students' face during the induction to a new tool for modelling and representation purposes. In that regards, no troubleshooting-related incident can be considered as generic, as every student request has been based upon model-specific questions and comments.

Additionally, troubleshooting appears as evident during the use or manipulation of AR models. As a result, this category is inextricably linked to the use and manipulation of AR models during the dialogues, both as solo interactions or as socially distributed interactions. An example of this kind of situations can be seen by the end of the transcript "Group 1 - AR based dialogue 1" in which a student shows Alberto an AR model on screen. They hold the laptop together in order to visualise the model properly (this incident is also included in the "technology driven organisational shifts" category) yet, is it not possible to visualise the students' work on the screen. This was caused by the lack of a common referencing system to allow the model to be displayed in a precise location in relation with the marker. For that reason, both the physical and the digital counterparts were misaligned (Figure 4.5). While this was not a critical challenge and the design critique was not particularly disturbed (they discarded that visualisation and moved on using different representations), this incident was directly linked to organisational shifts in the design critique, and to the socially distributed interactions taking place between the student and the instructor at that given time.



Figure 4.5. Video frame showing the misaligned AR model. The arrow at the bottom indicates the location of the marker on the top of the floor plan, while the arrow at the top of the screen indicates the actual location of the digital model.

4.3.5. Multimodal engagement

On an interesting observation during the coding and detailed analysis of the data, it is possible to spot gestures that indicate some **cognitive engagement** with AR models and representations during the design critique dialogue. Those specific actions were not spotted during the design critique sessions but instead, during the detailed video observations. This proves the usefulness of the utilised methods to spot explicit translations between internal and external representations (Goldschmidt, 1997).

Previous published studies have already described the use of gestures as means to spot cognitive activity via behavioural studies, especially in the field of psychology. In design, it also has been explored the cognitive engagement with models as knowledge carriers and the transit from internal to external representations (Goldschmidt, 1997). Even if this processes take place on a continuous basis throughout modelling and design processes, this category comprises explicit multimodal incidents which make such “cognitive machinery” evident.

The first incident occurs while Alberto (I1) speculates on the uses of AR models, immediately after students present the model on screen. He highlights the advantage of working with two overlapping representations at the same time, a floor plan and a 3D bulk model:

I1 ... an intelligent thing is, for instance (.) I have a project's floor plan and a model of the full volume (-)(.) while I design in the floor plan, while I am dealing with it, I have the other magic model as part of the design process

As recorded in the data transcripts, gestures provide additional information to understand how the instructor conveys this message. During the speech “*dealing with it*”, the instructor holds both hands next to his head representing some kind of mental activity, while immediately after that points at the screen to say “*I have the other magic model as part of the design process*” (Figure 4.6).

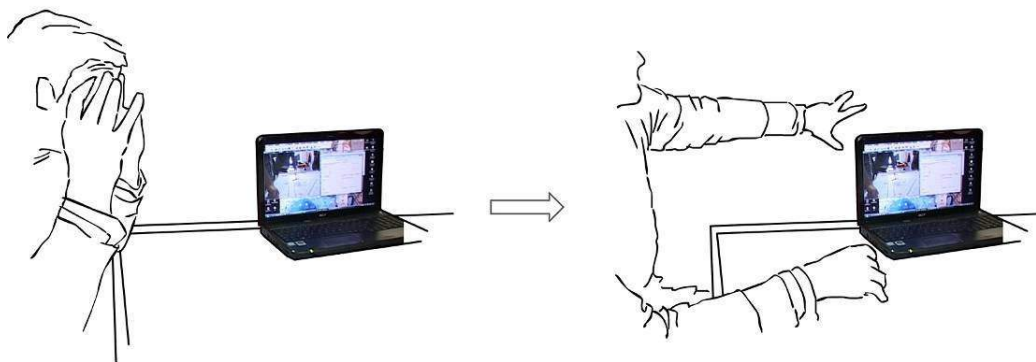


Figure 4.6. Gestural performance from Alberto indicating some cognitive engagement with the construction of AR models.

The context of the speech and the pace of the gesture indicate that he illustrated the fact of having an internal representation with which he can “*deal with*” while he has a digital counterpart on screen. This modelling-driven assembly across internal and external representations has not been observed as part of the dialogue and it occurs in the context of a speculation on the use of AR technologies for design - advising students on its potential use.

The second incident was performed by a student and, likewise, comprises a combination of speech and gestural communication. In this case the student is telling Alberto how he can interchange and test different digital representations

using AR technology. When he explains that models can be loaded into different AR markers

S1 Then we can substitute it (like this) (-) (5)

he performs a quick gesture, opening his hand next to his head and then moving it towards the printed floor plan (Figure 4.7). He indicates that different representations can be displayed on the top of the physical elements of the model. His gesture, which is seemingly close to “pouring” something from his head into the physical representation, indicates some engagement with the model as a way to externalise an internal representation or design idea.

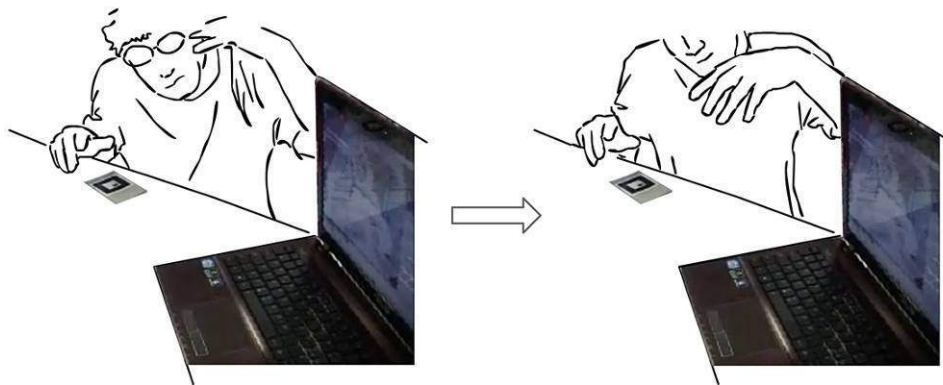


Figure 4.7. Gestural performance from a student indicating some cognitive engagement with the construction of AR models.

Overall, those two isolated incidents tell about the use of AR models as means of representation. Both, despite being performed during different conversations, were made in the context of users exploring the applications of AR technology for representation purposes. In the former case, the instructor is advising students about a possible application of AR technology (merging a floor plan with a massing model), and in the latter the student tells about the way in which AR could be used to display different design alternatives.

4.3.6. Emotional engagement

There is a thread of incidents that describes how informants feel about using AR applications. Such affective experiences include a range of emotions, such as satisfaction, fun or dissatisfaction. Also, senses of frustration are here included,

which overlap with those incidents also categorised as related to “troubleshooting”. Examples of this vary across the data, however typically found incidents are related to the satisfaction of the instructors after looking at AR models made by students, which in many cases is celebratorily acknowledged.

4.3.7. Organisational shifts

Changes on the organisational dynamics of the design critiques are included in this category and have been previously mentioned in this Chapter. Due to the use of AR models, not only the spatial setup of the design critique has been modified but also the roles of students and instructors as members of the group. Unspoken roles such as the “AR modeller” or the “camera holder” have been continuously emerging and shifting across groups of students in order to perform throughout their design critique session. This complex orchestration of roles and patterns has proven to be complex and usually following unspoken rules of engagement across members of the observed groups. Additionally, the change of roles usually entailed a shift on the pedagogical and power structures of the critique session. An example of this is the role of instructors while students operated AR models, in which they assumed the role of passive observers while students drive the design critique dialogues. While this has been previously reported in the literature (Webster, 2008), no previous work has been found to make use of a multimodal approach to depict organisational dynamics in design critique sessions.

4.4. FINDINGS OF THE DESCRIPTION OF FACE-TO-FACE INTERACTIONS USING AR MODELS

The observation of the data thoroughly describes the use of AR technologies in design critique sessions. The 7 categories being formulated account for a complete sequence of different design critiques with the support of AR models during face-to-face interactions in the design studio.

Evidence, even if limited, stresses some rather relevant findings, considering that this research calls to reflect upon pedagogic practices in the design studio. Among the most important ones are the organisational shifts confirming that AR can mediate the organisational dynamics and distribution of roles in a design critique session. While a detailed account of the power and authority dynamics in the studio is out of the scope of this research, relevant shifts can be identified,

which condition the uses and applications of AR technology. The fact that students curate and display their models using additional representational resources provides them with a higher amount of power over the critique dynamics, leading the way models are built and presented throughout the observed dialogues. This challenges the previous instructor-driven tutorial sessions, such as that utilised by Donald Schon to formulate his “reflection in action” theory (1983) and it has broad implications such as the need for an updated understanding of power and authority in the context of technology-mediated communication and representation in the design studio.

Likewise, dimensions of design learning which could be considered as normal in software training sessions (for instance those conforming the categories “technology affordances” and “troubleshooting”) are fully embedded into design critique dialogues, with strong interlaces across with models and members of the studio community. This potentially challenges the established view of software training as an extrinsic educational resource and puts it in the context of actual design activities, augmenting the design critique by incorporating such contents into the studio’s social fabric.

Lastly, multimodality proved as a resourceful approach for this research by setting a ground to collect, represent and transcribe data. Unobserved dimensions of design critiques such as individual interactions with models, emotional engagement with technologies or features hardly spotted on site such as gestures indicating some of cognitive engagement, were able to be grasped and described by following this approach. While here multimodality accounts for a rich description of face-to-face interaction, in the following **Chapter V** serves as a foothold to investigate contemporary communication in digital environments.

4.4.1. Conceptual integration

The process of clustering incidents into concepts aims to develop the building blocks of the “theory of augmented pedagogies”. Indeed, this is the first stage of the theory construction process of this research: further data is to be collected and added to the bulk of evidence. As a result, a grand theory accounting for the studied setting is not the aim at this stage, but instead a flexible set of concepts that account for the emergent categories, able to accommodate further changes and correlations.

Nevertheless, common threads appear throughout the data, allowing the emergence of early core topics. As a result, the 7 emergent categories have been grouped into **two core topics** that express the aforementioned findings: **augmented interactions**, and **pedagogic implementations of technology** (Figure 4.8).

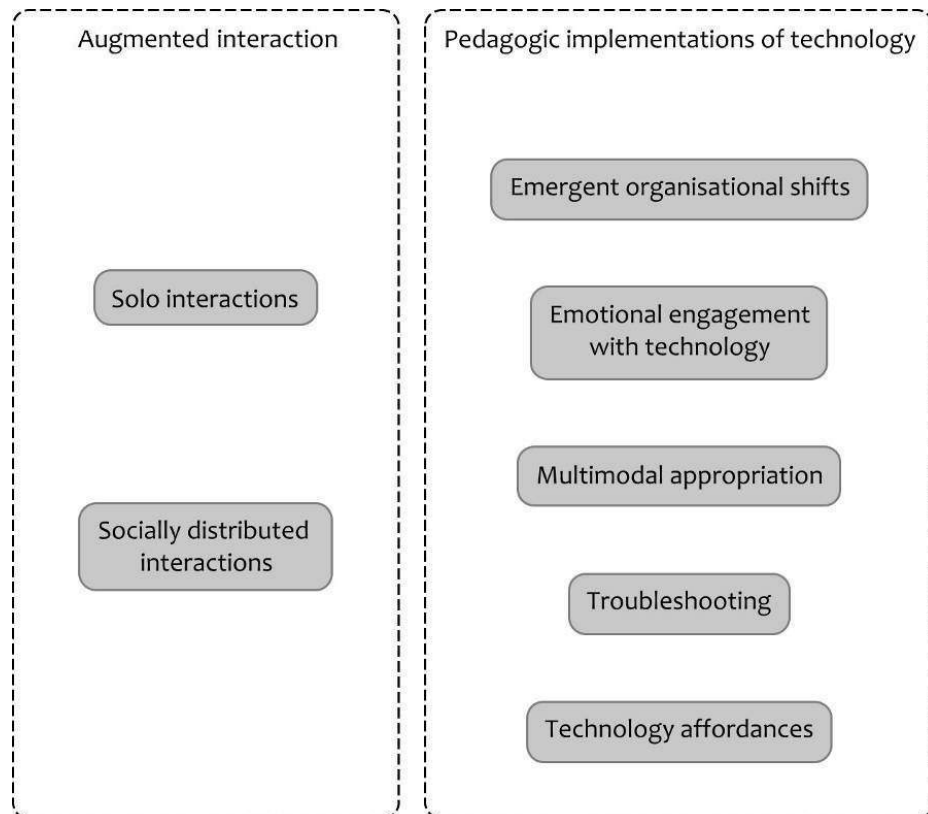


Figure 4.8. Initial grouping of conceptual categories into core topics.

4.4.2. Augmented interactions

Augmented interactions are the core topic grouping that categories of solo interactions, and social interactions. Broadly, this topic accounts for the relationships across models and members of the design studio during face-to-face communication. Among the relevant features of this core topic is that social interactions have been described as unidirectional - every incident is here described as isolated messages conveyed across members of the dialogues. Another remark regarding this category is that every coded interaction - in a 100% of the collected incidents - has been mediated or informed by a model and therefore, there was no

recorded dialogue not making use of a model to promote communication. This is particularly relevant when this topic accounts for solo interactions, where users independently and in isolation manipulate, observe or test a model without necessarily addressing their reflections and findings with other members of the design critique.

4.4.3. Pedagogic implementations of technology

Pedagogic implementations of technology, on the other hand, accounts for the different uses and roles of AR technology in design critiques, including speculative applications, attituded towards technology, troubleshooting and cognitive engagements with the tools, regardless which members of the studio community performed such grouped incidents. Some of the dimensions that comprise this concept have been usually relegated to software training courses, such as troubleshooting or technology affordance. For this reason, it is relevant to observe how the different incidents that structure each concept are inextricably interlaced across the data, then turning the understanding of the design critique as a promising space to learn new representational tools in the context of actual student-driven design processes and products.

The complex intertwines across modes of representation and interaction repositions our understanding of design pedagogy, and therefore provides clues and opens polemics across the current educational praxis. For instance, this core topic provides evidence of dimensions usually left unobserved in architectural education research, such as the understanding of different corporeal and emotional dimensions of learning (Webster, 2008).

Additionally, the widespread trend of isolated software training courses, opposite to a design-based implementation approach, can be now questioned from the evidence. Allegedly such software-centred pedagogical models diminish social interaction, as it is usually utilised on a delivery scheme based on instruction and repetition. On the other hand, learning new tools and methods of representation can be conversely implemented as part of the pedagogical and social dynamics of design studio teaching and learning.

4.5. SUMMARY AND CONCLUSIONS

This Chapter has introduced an initial set of concepts, their categorisation and clustering in core topics that aim to describe the use of AR models for design critique sessions. Design critique sessions have been observed on site, recorded and transcribed into data sets analysed through a sequentially structured coding process. After a detailed dissection of the data, supported by additional research methods, a full description of the impact of AR models in design critique sessions comprises 7 categories of incidents. Those categories have been informed by the data, and additionally describe the different dimensions to be accounted for when infusing AR tools in design studio activities: solo interactions, socially distributed interactions, technology affordances, troubleshooting, multimodal appropriation, emotional engagement with technology, and emergent organisational shifts. Further, such categories have been clustered into 2 core topics that describe the data: augmented interactions, and pedagogic implementations of technology.

Recalling the objectives of this research, such classification of the emerging categories suggests the potential understanding of multimodal interaction as pedagogy, and how pedagogy is continuously and socially reshaped through the use of communication and representation resources. In that sense, the work has addressed multimodality as a relevant approach to investigate the observed phenomena, enlightening incidents and descriptions that could be hardly discovered by making use of monomodal data transcription systems. The use of multimodality confirms the methodological apparatus described in Chapter 2 and complies with the second objective of this work: **to develop a multimodal research approach and its corresponding methods and tools for architectural education research.**

Additionally, this Chapter has built a series of interrelated concepts that explain the impact of AR tools in face-to-face communication in design studios. This output is the first step towards the construction of the theory of augmented pedagogies, which is the third objective of this research (**to construct a series of descriptive interrelated concepts, and a subsequent framework upon which a theory of augmented pedagogies is based**).

CHAPTER V

**BUILDING FRAMEWORKS:
ANALYSIS OF STUDENTS'
COLLABORATIVE
WORK USING WIKIS**

5.1 INTRODUCTION

This Chapter expands the theory construction process, by investigating communication dynamics across the members of the studio community using Wikis. The relevance of this research stage is twofold: while it expands and refines the descriptive conceptual vocabulary developed in the previous Chapter, it additionally aims to elicit correlations across concepts and categories, structuring such conceptual vocabulary into meaningful pedagogical frameworks to describe the impact of communication resources such as AR and Wikis in design studio education.

As mentioned in the Introduction, the argument of this Chapter lies on the understanding that online communication operates without specific temporal or location boundaries, and therefore it is possible to observe students' work outside teaching hours. This comprises a series of usually unobserved dimensions of design studio teaching and learning outside teaching hours, such as the use of tools for communication, design decision-making, group and studio dynamics, or the role of instructors as facilitators of online modes of learning. Following a multimodal approach, this Chapter observes such dimensions by focusing on the analysis of modes of communication and their intermodal relationships facilitated through the use of Wikis, that is the students' use of text, images and layouts in the Wiki sites.

The context for the research stage presented in this Chapter has been set by a Higher Education Academy project at the Liverpool School of Architecture in 2013. Granted to Dr. Tuba Kocaturk through the Individual Grant Scheme, the project "Reflective and dynamic use of Wikis to support collaborative design learning" aims to "develop and test a new online approach in "collaborative design learning" in architecture education where individual, collaborative and guided learning will be interlinked within the same pedagogical framework" (Kocaturk et al, 2014). This project has been implemented in a MA design studio course at the Liverpool School of Architecture, with a group of 34 students. Students have been organised in groups of commonly 3 members each, in which each group member assumed different roles throughout the design process: knowledge manager, architectural designer, and engineering and manufacturing consultant. Such organisation has aimed to outline specific roles to promote interdisciplinary collaboration within each group, to organise the contents in the Wiki sites and to

compartmentalise the workload allocation throughout the course. One of the specific tasks of the knowledge manager is to update the Wiki sites for each group, which are fostered within the University of Liverpool's Blackboard system.

5.1.1 Structure of the Chapter

Initially the Chapter describes the main features of online learning in architectural education, and previous experiences conducted both internationally and in the University of Liverpool (Knight et al, 2007; Knight & Brown, 2010; Kocaturk, 2014). Coincidentally with this research, the University of Liverpool has a track record of experiences and investigations on the use of Wikis in architectural education. As a result, this section of the Chapter provides a context for this research stage, by reviewing some international experiences but additionally by building a continuity across related works conducted at the Liverpool School of Architecture to support design education since 2007 (Brown, Knight & Winchester, 2007).

Then the theoretically relevant materials elicited from the Wiki sites are described. The core foci of multimodal communication dynamics using Wikis are here described as “**design and construction of the Wiki sites**”, “**group-specific interactions in the Wiki sites**”, and “**studio interactions in the Wiki sites**”. It has been observed that the construction of the Wiki sites provides relevant information related to the use of text, images and assemblies across texts and images into blocks of contents. Nevertheless, students have made use of Wikis to additionally record and upload minutes of their group meetings and design work, expanding the array of representation and communication resources utilised throughout the different observed Wiki sites. Lastly, students have been allowed to interact with other groups' Wikis. Such studio interactions have provided insights into a broader extent of interactions, those across members of the studio community regardless their role (either students or instructors), group affiliations and design approaches.

After those findings are described, the Chapter revises the conceptual categories - the building blocks of the theory of augmented pedagogies. Here, categories are to be expanded on their definition, and their description is furtherly developed by adding the new findings into the pool of theoretically relevant material to be

allocated in the theory construction process. At this stage, relationships across categories are discovered in order to provide a structure for the construction of emergent technology-driven frameworks.

Finally, a discussion of the findings is presented together with the conclusions of the Chapter. These are mostly focused on the modes of communication observed through the use of Wikis, the role of instructors and “instructional modes of communication” as a counterpart of the students’ “curatorial modes of communication”, which has greatly shaped the observed communication dynamics.

5.2. GENERAL FEATURES OF THE USE OF WIKIS FOR DESIGN EDUCATION

It is well known that design studio culture comprises high amounts of peer interaction, both in and outside teaching hours. What is sometimes considered as a traditional practice in architectural education, informal learning is the place where students produce their models and make relevant design decisions, progress through their design process and collaborate with peers - whether the design brief states so or not. Differently from the face-to-face interactions with instructors which are mostly based on dialogical feedback, this study has found that outside studio time students learn different contents (tools and modelling methods, decision-making, among others), in different locations (individual work from home, collaborative work in the Library, among others). In that sense, some evidence suggests that the ways of learning performed by students during informal learning situations is quite distinct from the ways of learning during studio contact times with the instructors (McLean & Haurigan, 2013). This important dimension of architectural design education has been, nevertheless, rather unobserved. The work of McLean & Haurigan (2013) conducted an extensive research on design studio interactions, and the effectiveness of student-instructor interactions during studio teaching time. Among their conclusions and recommendations for further work they stress that, regardless of the pivotal role of student-instructor interactions for studio education, “the capability of peer dialogue to support transformative learning receives no commentary in the literature and would be a valuable area of study.” (p. 52).

So far, however, few research resources to depict students’ work and

collaboration outside teaching hours have been reported (e.g. Vowles et al, 2012). An emphasis on individual work based on unknown locations renders a monitoring process into a challenging task. Invasiveness to students' privacy, monitoring of students' work outside an academic environment or the lack of systematic and consistent working modes and locations outside the studio spaces can be mentioned among the methodological, ethical and logistic challenges of such observations. Today, however, a series of technology resources allow us to investigate students' work and communication outside teaching hours. Their use of social media and ICT tools, together with a high degree of ubiquity and connectivity allow the monitoring of students' work by using online resources. This research opportunity is also aligned with the growing institutional demands for ICT supports for teaching and learning, such as the development of digital literacies and digital employability skills in Architecture students.

Specifically in the context of this research, Wikis have been in use for some time at the Liverpool School of Architecture (Knight et al, 2007; Knight & Brown, 2010; Kocaturk, 2014) aligned with the Educational Development recommendations of the University of Liverpool. The Developing Digital Literacies group has drawn a set of guides and suggestions in relation to the use of digital and ICT tools for learning. Among the core updates made to the "Learning and Digital Literacy Skills Development Guidance document" (2013), are those following an "increased student expectation in relation to the ubiquity of digital technologies; and increased focus on employability skills and increasing demands for competencies in a rapidly developing digital work-market" (p. 1). However, considering the disciplinary differences among the use of digital and ICT tools, the Developing Digital Literacies group has requested each academic unit to develop their own Learning and Digital Literacy skill plans. Aligned with this, a commonality found in the literature reporting the use of Wikis for design education is the institutional pressure to cope with distance learners, increasing students numbers and the need to promote the digitally-assisted delivery of contents. In the design studio system, however, students seem to prefer face-to-face interaction and good quality dedicated time for design tutorials and critiques (Knight & Brown, 2010) rather than the online provision of design-related dialogical feedback.

5.3. DEPICTING STUDENTS' MULTIMODAL COMMUNICATION USING WIKIS

As already reviewed in **Chapters 2 and 3**, modes of communication in on-line environments vary greatly from those utilised during face-to-face interaction and thus, require different observational methods. Wikis are collaboratively built websites which can be created and edited by the authors (the students, in this case) yet, still able to receive comments and editions from third parties (other students and instructors). The construction of Wikis comprises a broad range of possible media resources (video, animations, among others) yet in this experiment most of the content is displayed by using images and texts. Those modes of communication are not isolated from each other, as their organisation into layouts, reading and navigational paths also offer valuable information in regards to how content is curated, communicated and displayed throughout the different sites. Additionally, the mode of diffusion of content itself shifts from printed materials and physical models towards the use of a screen as a display medium (Kress, 2010).

The construction of the Wiki sites follows a rather straightforward method. By using an on-line editor within the University Blackboard system, students upload images and texts as required. By using basic editing tools they are able to create additional navigational paths such as links across pages and links to external resources. Once the pages are created and linked to each other, students are able to use forums to communicate through comments in their Wiki sites. It is not the aim of this work to map the complex extent of their design process by detailing the links and relationships across contents in the students' Wikis. Recalling the need for a theoretical sensitivity (Glaser & Strauss, 1963) to select the relevant data sources, the observation of the different modes of communication and their assemblies to effectively communicate their design ideas and processes are the foci of this Section.

Three different foci of analysis have been identified as relevant. The first one is that of design and construction of the Wikis, which details how different modes of communication are assembled by students to curate and publish their work. The second focus of analysis, group interactions, deals with how students agreed on such contents and decision-making through conversation sites. In that sense, Wiki sites often include a group "conversation page" used as a mean to record the

internal dynamics of each design team throughout the semester. The last focus of analysis is that of the studio interactions through the Wiki sites and is referred to the communication across members of the studio (including instructors and other design teams), usually through text-based comments in specific forums. The following description does not comprise the detailed observations of every Wiki page, but instead an illustration of the core descriptors of each one of the aforementioned areas of analysis.

5.3.1. Design and construction of the Wiki sites

Decisions upon the layout and construction of Wikis have been a primary task of the “knowledge manager” in each design team. Wikis were continuously updated with relevant information that teams choose to communicate with instructors and other students. The design of a Wiki site can provide high amounts of relevant material in regards to communication of on-line content. The assemblies across text and images and their graphic resources (colour, fonts, and so on) can indicate navigational paths, contents’ organisations into blocks, or reading sequences.

Likewise, the screen as the medium of display - differently from physically printed representations - constrains the reading path within the basic occidental sequence (from top to bottom, and from left to right). This shift on the way communication is organised and displayed has been a matter of recent research on multimodal research. In his work “Literacy in the new media age”, Gunther Kress (2006) states that screens, differently from printed media, have not a linear reading sequence and there is no single “entry point” to begin “reading” from, but instead content is organised into “blocks” of text and images with similar meaning. The following image shows a representative Wiki screenshot by Group 2 (Figure 5.1).

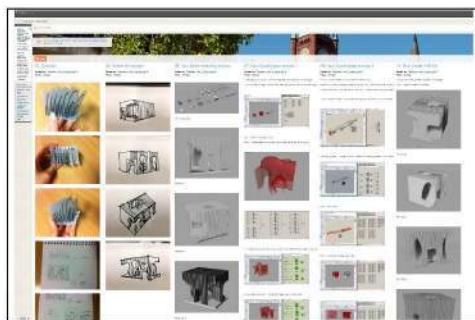



Figure 5.1. Sample Wiki site. Contents are here organised in columns. Source: University of Liverpool Blackboard system (2014).

The site is organised following rather common principles - a sequence of content organised from top to bottom into column-like blocks of information, and supporting menus that display different options for the reader on the top and left sides. However, a closer look reveals the series of possible “entry points” of the site. For instance, on the left side menu there is a log of the user’s activity, which is useful information for this research as it allows monitoring the students’ use and edition of the Wikis. At the top margin, there is a different “block” of graphic elements allowing any user to navigate through more specific bits of information, that of the content in each one of the columns. In that sense a quick view through the sites already suggests the stages of a process, commencing with simple hand-made sketches and then progressing towards a more complete massing model.

While this is a website that explains a larger design process, students also produced Wiki sites to explain the detailed development of each of their design stages (Figure 5.2). This site structure is the commonality across the students’ work, and is that of an assembly between texts and images arranged vertically, where supporting material (in the form of images) follows a rather brief text-based introduction. In that sense, a site-size block of information is displayed with different levels of detail. As in the previous sample, links are built on the right-hand column, allowing a viewer to situate this content into the larger picture of the students’ design process. The relevance of these sites is that, nevertheless, the array of resources utilised by students fits with each stage of their design process, such as the sketches and written texts which are usually scanned and uploaded to their Wiki sites. Those images, at the same time, are built by the assembly of drawings, handwritten texts, 3D model screenshots, and a parametric model screenshots. Those diverse types of representations in addition to the text-based heading of each block help maintain the coherence and consistency of each block. In Figure 5.2 some images have been deleted for the purpose of the visualisation of the site, which is overall a rather long sequence of representations.

Given the higher density of detailed information, these sites are usually the ones in which instructors interact with students, by providing feedback based on what students choose to display. This has been confirmed in the interviewing stage of this work, in which students have explicitly declared that their main focus of attention when building a Wiki site is that of “showing contents to instructors”.



Group 10 Wiki
[+ RSS](#)

[Subscribe](#)
[Export](#)
[Settings](#)
[Permissions](#)
[Widgets](#)
[Assessment](#)
[Page List](#)
[Attachments](#)
[Recycle](#)

Visible to: 101314-ARCH423 - COMPUTER
AIDED ARCHITECTURAL DESIGN PROJECT (ARCH423-201314) - All Instructors, Meng Li, Zuliang Qu, Teshome Tulu

The seventh group meeting

Edited by Meng Li on 11/4/2013 at 7:41 PM, GMT.
Tags: None (Edit)

Edit | History | Lock | Delete

Add New Page

Pages (Edit)

- Homepage
- Introduction
- Initial Design Concept(First group meeting)
- Second group meeting
- Third group meeting
- Fourth group meeting
- The newest problem
- The fifth group meeting
- The sixth group meeting
- The seventh group meeting*






Tags

No tags

Page Contributors

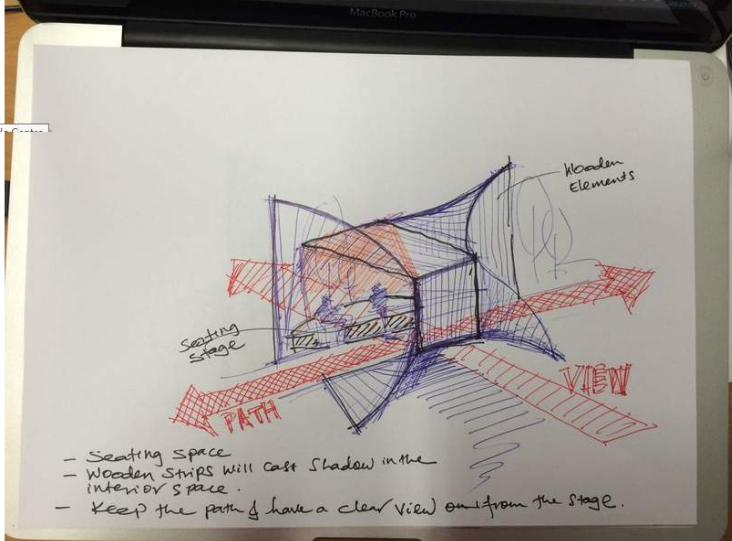
Meng Li

Latest Activity

-  Meng Li updated "The seventh group meeting." 15 hours ago
-  Meng Li updated "The seventh group meeting." 15 hours ago
-  Asterios Agkathidis added the comment "so more comments on your work:" to "The seventh group meeting." 19 hours ago
-  Asterios Agkathidis added the comment "good! i will commend in more detail soon!" to "The seventh group meeting." 3 days ago
-  Meng Li updated "The seventh group meeting." 3 days ago


[View all activity](#)

Sketches



Count: 70

Viewer Comments (2)




good! i will commend in more detail soon!

Made by Asterios Agkathidis on 11/1/2013 at 7:20 PM, GMT.

[Edit](#) | [Delete](#)

[Reply](#)



so more comments on your work:

Made by Asterios Agkathidis on 11/4/2013 at 2:58 PM, GMT.

[Edit](#) | [Delete](#)

I would get rid of the stage...you could manipulate the surface, thus it forms a stage though... could you post your script snapshot... so I can see how you have build it up? might can help there too...good progress though!

[Reply](#)

[Close commenting](#)

Viewed 39 times.



[View Pages in High Contrast](#)
[Help](#)
[Feedback](#)

Figure 5.2. Sample Wiki site. Source: University of Liverpool Blackboard system (2014).

This rationale and understanding of an “audience” and a “reader” is aligned with the logics of text- and meaning-making proposed by Kress (2010). In this case, one of the comments from an instructors is detailed as follows

“I would get rid of the stage ... you could manipulate the surface thus forms a stage though ... could you post your script snapshot, so I can see how you have build it up? Might can help there too (sic) ... good progress though!”

Even if rather succinct, the instructor here delivers a message that consists on feedback about the design (“*I would get rid of the stage...*”), as well as about the use of representation and modelling tools (“*... you could manipulate the surface...*”), and the density and contents of the information that students display (“*...could you post your script snapshot...*”) in the Wiki site.

5.3.2. Group interactions in the Wiki sites

Students have been organised in 10 groups, each having a role playing structure for studio purpose. Wikis comprise a public area, viewable by every member of the studio, and private sites in which students can upload material and records without making it publicly available. Overall, the 10 groups had a total of 97 sites, organised into their 10 Wikis. While some are brief records of meetings and specific topics discussed in such meetings, some are longer records of the use of certain tools and development of new design alternatives - such as the one already detailed in Figure 5.2.

The internal dynamics of design teams outside studio teaching is a critical dimension of studio education. As the design process progresses, important decision-making stages are fostered within such dynamics and several groups managed to record some of their interactions in the Wikis. As it was clarified during the interviewing stage of this work, the recorded interactions are only partial as groups made use of several other means of communication.

A first finding is the nature of the text-making itself as part of the groups dynamics. The primary aim of the Wikis, at least in what concerns to the students’ role, is to record the learning and design process throughout the semester. Expected products then are closer to an archive of the semester activities and design procedures, decision-making meetings or progress reports. Those types of

texts are largely presented, yet mixed with personal and more intimate accounts of group dynamics that, in some cases, have some high levels of disclosure. As a result, a collective creation of personal publications is obtained as a mean to record not only learning and design processes but also organisational and societal dynamics within the groups. The following example is a piece of text obtained from a design team's "conversation page" (bold highlights are mine):

Hello,

*Whenever we have any **pictures of development**, research examples or mindmaps would you be able to answer some or all of the following questions so an explanation can be applied to the images.*

- What the image is*
- What **stage of the design** the image is for.*
- What problems you encountered*
- How this image aids the design*

Please don't forget to be critical about the work.

*Nothing is perfect and there is always room for improvement but to explain this project is best potential **we have to show our mistakes and what it is we have learnt from them.***

*Also I have renamed your sections under your working titles so please **feel free to insert any information but could all images come through me so I can crop them to the correct size.***

Happy happy designing people!

The way these types of texts are embedded in the context of personal publishing is described from a multimodal perspective by Eisenlauer (2011). He states, among other claims, that these types of texts are deeply embedded into certain discourses, contexts of construction and collective collaboration. The fact that students use a "designerly" jargon ("*stage of the design*", or "*stages of development*"), as well as a rather target-directed conversation (that of clearly describing their working images) confirms this. Likewise, information about their social dynamics is present in the text. Whilst some extracts are closer to provide evidence of their own learning process as a group ("*...we have to show our mistakes and what it is we have learnt from them*"), others are more focused on their collaborative use of tools to create the Wiki sites and display their work ("*...feel free to insert any information but could all images come through me so I can crop them to the correct size.*").

Additionally, group interactions have been recorded using a multimodal assembly of both text and images. Some design teams recorded their group meetings in the form of collaboratively-built sketches, mind-maps with different design options or the scanned version of their meetings' handwritten notes. These graphic resources add layers of visual information to the depiction of group dynamics which, in some cases, is supported by texts, therefore allowing a more public and traceable design process if students decide to engage with the Wiki sites. Figure 5.3 shows a hand-made minute of a group meeting, explained by students as

"We furthered (sic) our working on the concept of "flowing notes"."

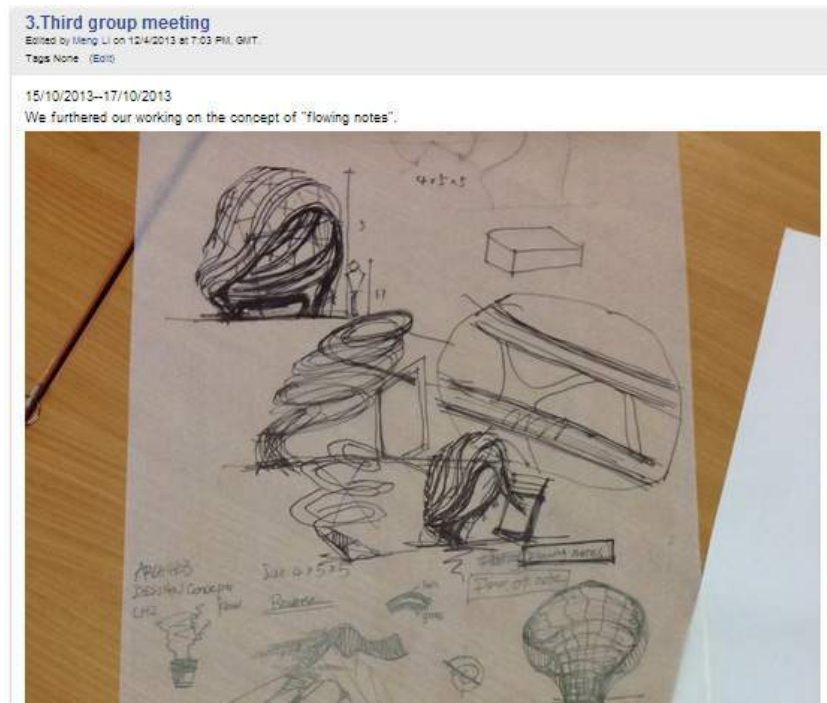


Figure 5.3. Sample collaboratively-built sketches. Source: University of Liverpool Blackboard system (2014).

Yet unclear, sketches provide students' insights on issues related to the form and structural elements of their design, a footprint of the collaboration across the roles of designer and structural/manufacturing engineer. Additionally, some understanding of the scale and size of their pavillion is suggested through early annotations such as dimensions and human figures. Such multimodal construction of ideas is aligned with the previously mentioned advantages of recording societal

dynamics during group interactions by “building/agreeing on design ideas”, which has been mentioned in the interviews as one of the core uses of Wiki sites. Additionally, similar group dynamics have been observed throughout the course of the semester, in which the level of detail and modes of representation shift towards more elaborated representations of their design project as the course proceeds (Figure 5.4.).

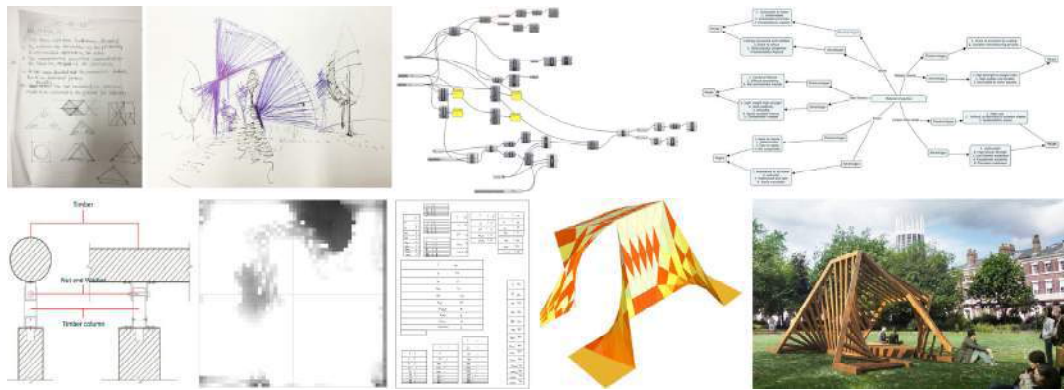


Figure 5.4. Different representations utilised by groups of students to display their design work, including (from left to right, top to bottom): meetings minutes, sketches, parametric modelling sequences, mindmaps, drawings, sun shading analyses, fabrication patterns, 3D models, and renders. Source: Kocaturk et al, 2013.

5.3.3. Studio interactions in the Wiki sites

At some points of the semester, Wikis were publicly available for the rest of the students in the studio. Given the already described records of the design and learning processes, Wikis were not openly available during the complete semester. Instead, teams are asked to “go public” at some points of the course in order to facilitate collaborative work across different groups in the studio. Instructors, on the other hand, had permanent access to the Wikis to provide feedback.

“Going public” meant that design teams set levels of publicity into their Wiki sites, regardless some pages could still remain as “private”, usually utilised as unstructured private repositories of information - a kind of digital scrapbook. In that sense, navigational paths and available information in the Wikis were decided by each group through a set of networked links, and students and instructors interact with other teams through text messages on each site. Other group

members are not able to edit the Wiki sites, so this type of interaction were found to a lesser extent, and expressed through text-based forum messages.

Given the diverse nature of the groups' design proposals and processes, studio interactions were found to focus on the commonly utilised tools and methods across different groups, such as software training or digital modelling techniques. In that sense, students seemed to explore other groups' sites searching for alternative modelling and representation ideas. An example of this behaviour was often found when groups decide to publish their digital models. Figure 5.5 illustrates this type of studio dynamics.

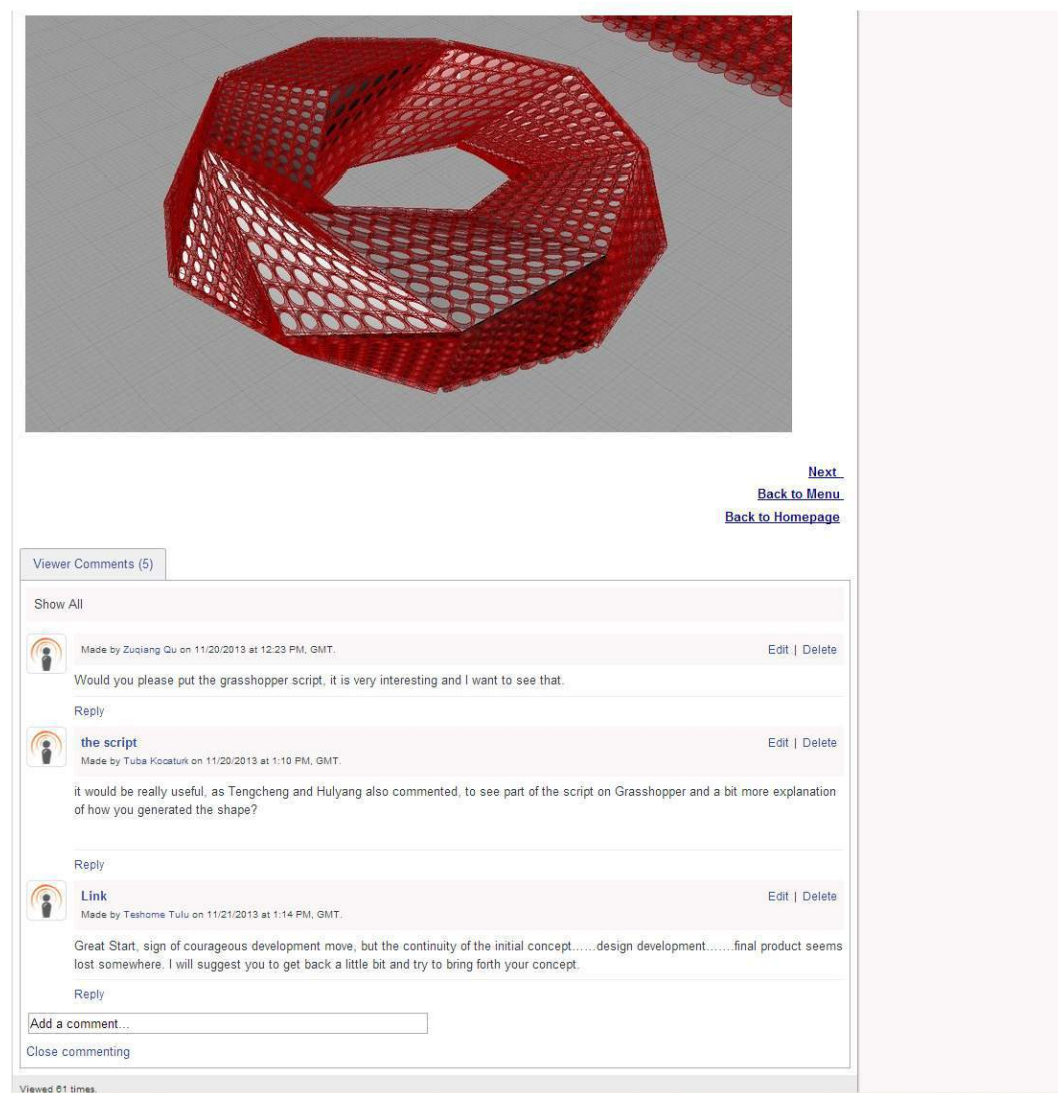


Figure 5.5. Sample Wiki site. Source: University of Liverpool Blackboard system (2014).

In this site, students published a method to tessellate and model complex geometries making use of the modelling tool Rhinoceros 4.0 and its parametric engine Grasshopper. While still exploratory, other studio members demonstrate interest on this tessellation technique rather than in the design product itself. The first comment, made by a student visiting the site, is as follows:

Would you please put the grasshopper script, it is very interesting and I want to see that.

Following the thread of the conversation, a studio instructor followed this enquiry by stating

It would be really useful, as [name of student] and [name of student] also commented, to see part of the script on Grasshopper and a bit more explanation of how you generated the shape?

Lastly, another students' comment went further, and provided some peer feedback more closely related to the design process than on the tools utilised to create the models:

Great start, sign of courageous development move, but the continuity of the initial concept ... design development ... final product seems lost somewhere. I would suggest you to get back a little bit (sic) and try to bring forth your concept.

As seen, peer feedback was often found related to the use of tools and methods, yet to a lesser extent provided some insight into inter-group feedback. Differently from the previous descriptions of Wiki-supported interactions, studio interactions took place as a monomodal communication, that of using written text on the Wiki's forum spaces. As a result, there was no assembly across other previously considered relevant modes of interaction, such as images or the construction of layouts.

5.4. BUILDING FRAMEWORKS: REVISITING AND STRUCTURING CONCEPTUAL CATEGORIES

After describing on-line communication using Wikis, this section explains how such observations generate additional insights into the existing concepts and categories of the theory of augmented pedagogies. The existing categories are now revisited and contrasted with the new findings, on an attempt to expand and reinforce the definition of **solo interactions, social interactions, technology affordances, troubleshooting, organisational shifts, emotional engagement,**

and **multimodal engagement** in design studio education. In that sense, it is relevant to point out that the contribution of the new findings towards the theory construction is twofold:

Firstly, new findings are added to the bulk of information generating the theory by considering additional dimensions of studio teaching into the theory outcomes of this research, therefore expanding the applicability and reach of the resulting theory. New theoretically relevant material can generate additional definitions and correlations across categories not constrained to the solely analysis of design critique sessions. As a result, the involvement of additional data derived from an informal learning context provides a more complete picture of studio teaching dynamics.

Secondly, new theoretically relevant material has been harvested by following a different, yet complementary set of methods for online monitoring of students' work. In online communication, modes and media differ greatly to those utilised for face-to-face communication and as stated in Chapter 3, methods have been shaped accordingly. As a result, considering these findings into the theory construction process implies a broader research methods toolkit, aligned with grounded theory research in which a constant comparative analysis produces a theory that accounts for multiple observed incidents yet can still accommodate and organise new emergent knowledge.

5.4.1. Evolution of the conceptual vocabulary into emergent pedagogical frameworks

Relevant incidents can be identified from the observation of multimodal communication using Wikis. Coding such incidents, allocating them into the existing categories and expanding their definition are the theoretical development stages described in this Section.

The allocation of incidents into the existing categories follows a coding procedure. Yet, differently from the initial open coding process described in Chapter 4, now existing categories are utilised as an existing classification in which incidents are allocated accordingly. It has been relevant to depict the complex extent to which different incidents are inherently interlinked with each other. For instance, during the design and construction of Wiki sites, students have made use

of complex arrays of communication resources, including images of different models and representations of their design work, throughout different stages of the design process. The modes of communication utilised at this stage have been identified as images, texts and layouts, and have been utilised at different scales: from the overall view of a group's project to the detailed visualisation of specific design stages and scenarios. Such **[multimodal engagement]** has allowed students to reach a well-defined set of goals, as declared in their interviews (Figure 5.6), including communication with the instructor, building and agreeing on new design ideas, or keeping a records of their design process and progress.

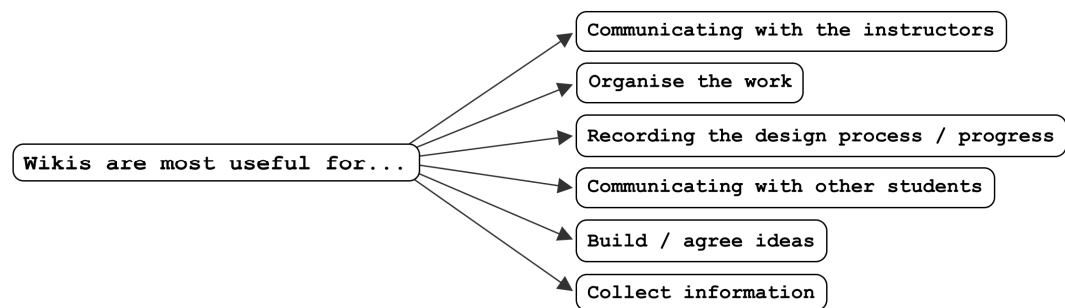


Figure 5.6. Perceived benefits of using Wikis throughout the studio course. Source: Kocaturk et al. (2014).

The construction of the Wiki sites has been arranged in accordance to the group meetings, and usually following a display of a week-by-week progress throughout the course. In addition to the record of group meetings minutes, and evidence of groups' collaborative work, Wikis provide useful footprints of **[social interactions]**, as well as of **[organisational shifts]** throughout the roles being assumed by each group member. In terms of the roles from instructors, comments found throughout the Wiki sites provide evidence of not only design-related feedback, but also feedback related to the use of the Wikis (such as requests for uploading and displays certain materials), the density and amounts of information being displayed, and further advices on specific modelling and representation tools, therefore suggesting an understanding of the **[technology affordances]** of Wikis. While these comments are rather project-specific, they have been commonly found throughout all of the groups' sites and comprise relevant feedback on the design and construction of the Wiki sites.

A similar set of emergent correlations across categories has been found in both the group dynamics using Wiki sites, and the studio dynamics using Wiki sites. Overall, 111 Wiki pages have been produced usually following a linear layout (top-bottom organisation), each one with a corresponding set of images of 4,3 per page, in average, being most of them related to the design process of the pavilion (design brief), and to a minor extent to the modelling process explaining the use of parametric modelling tools. An exception of this are the “communication” pages where students have transcribed a series of e-mails and meeting minutes based only on text. The modular organisation of Wikis has been usually constrained to the capacity of the Blackboard system and mostly dedicated to provide a structure of the website, such as menus and links, and the comments forum as indicated in Figure 5.2.

Among the most relevant findings, it can be mentioned that:

- As expected and given the intrinsic collaborative nature of the studio organisation and design brief, no **[solo interactions]** have been identified as part of the bulk of relevant observations of the Wiki sites. A deeper analysis of the interviews suggests that, however, individual learning is highly focused on the acquisition of skills and control over representational and modelling methods, such as the construction of digital 3D models (Kocaturk et al, 2013). In that sense, software training and its resulting operational knowledge remain as a highly individual component of technology-mediated learning in design studios. Evidence of this are the posts on the Wiki forums identified within the analysis of studio interactions.
- The **[organisational shifts]** across group members, such as the identification and use of roles throughout the design process, has been expressed through the publication of text-based communications, using “communication sites” composed mostly by verbatim transcripts of e-mails. This monomodal expression of group interactions is aligned with those interactions across groups (studio interactions), that also make use of text messages in forums and are highly focused on **[troubleshooting]** and enquiries about **[technology affordances]**, that is how certain modelling and representation methods work. While this monomodal

behavioural pattern is greatly conditioned by the affordances of Wiki sites, further insights into the multimodal nature of peer collaboration can be suggested for further work.

- It has been relevant to consider that all categories have had some participation on the analysis of the use of Wikis for communication. Despite some conceptual categories such as **[organisational shifts]**, **[multimodal engagement]** and **[technology affordances]** are seemingly more densely related to the use of Wikis than other categories, the set of categories has proven to be flexible enough to allocate this new set of observations, and to allow the discovery of linkages across categories into meaningful frameworks that describe communication patterns in a social context. For instance, it can be reported that solo interactions with Wikis are usually related troubleshooting, as students tend to individually learn about the use and operation of the Wiki sites. However, social interactions with Wikis are usually focused on an exploration of the affordances of technology (what they can do with it), they help us depict organisational dynamics within the students' groups, and that their engagement with Wikis proceeds on the basis of a meaningful multimodal assembly across text, images and layouts in which the audience is primarily the group of design tutors.

5.5. DISCUSSION AND CONCLUSIONS

With an increasing focus on (moving) images rather than text as a mean of communication, online environments comprise a series of different modal resources for meaning making: layout, information arrangement, navigational paths, modularity, colours, and so on. This shift in contemporary literacy and its impact on the curricula provision has been hardly observed in architecture students.

As seen, Wikis do not fully illustrate the contemporary shifts in on-line interaction and communication. Recalling previous Chapters, students learn how to design to a high level of complexity, with interrelated uses of tools, methods, communication and representation resources. In relation to the use of on-line support for design studio education, ever-evolving social networks are now

disrupting the understandings of human privacy, physical interaction, human relationships or data sharing and retrieval. In that context, Wikis nevertheless remain as flexible yet, simple user-driven logs of activities based on text-based posts, image and layouts. Among the core advantages of using Wikis to observe design studio communication are those of observing students' communication patterns outside teaching hours, creating insightful records of their design process, and describing how online communication re-shapes teaching and learning.

5.5.1. Instructional and curatorial modes of communication using Wikis

The collected observations show that students use Wikis in various ways, shifting the way communication operates when compared to face-to-face interactions. Evidence suggests that the use of Wikis does not only modify communication in more notable ways (such as the obvious shift between synchronous to asynchronous communication) but it additionally serves as a mean to shift relations of authorship and design communication throughout the learning process. In that sense, after the observation of face-to-face interactions, on-line collaboration allows the observation of a complete new set of roles and modes of communication across the members of the studio.

The image of the design instructor as the driver of the students' learning process can be hardly questioned. Part of that academic authority is usually at use during design critique sessions, being the instructor a lead of the conversation, asking key questions and freely observing and commenting through different models as the dialogue proceeds. In the Wiki sites, however, this role shifts towards the student. They admittedly consider the instructor as an "audience" of their work, and contents are produced and curated accordingly by students, who ultimately lead the feedback process. Moreover, they decide how different modes of communication are coordinated in order to display such contents. Text-only, image-only, or assemblies of text and images into blocks of information have been identified as possible ways in which students decide to display their design processes and products. The instructor then becomes the target audience of the Wiki sites, with no direct control over neither the content nor the way the content is displayed. Students are then able to communicate different dimensions of design which is

conveniently shaped towards their instructors, shifting the power balance in what respects to authoring and curating their material. McClean & Hourigan (2013) state, among other findings that even if the instructor-student interaction has a specific power dynamic, it is equally important for the student to perceive such authoritative guidance in order to gain confidence in their work.

In more specific situations, however, curatorial modes of communication shift across students and instructors. After observing instructors assuming the role of curators during face-to-face design critique sessions by selecting the relevant lines of discussion and representations to be observed, students select and display their work in the Wikis considering the instructor as an audience for their work. In the most relevant difference between face-to-face interactions and Wikis interactions with instructors, instructors' role is now constrained to that of an observer of the content, leaving aside their capacity to collaboratively represent their insights and guidance in the form of design representations (e.g. sketches, annotations). Even though instructors select and decide which models to explore, build or talk about throughout a design critique face-to-face interaction, such actions rely on students during the design and construction of Wikis. There are, then, changing roles that shift the power and authority balances in the studio teaching and learning dynamics.

Similarly conducted research projects, such as the one reported by Gray & Howard (2014) using Facebook groups, seem to confirm these findings. This publication provides evidence of the engagement of students working in groups of 5, with Facebook groups created to support design studio's communication. They claim that student-driven conversation in the Facebook groups comprise a hidden curriculum of the design course, as both "formal and informal patterns of communication" shape the learning experience. Also some contents seem to relate to more specific modes of teaching, as "certain kinds of learning may be more easily imparted via designerly talk with peers and practitioner/alumni than might have been possible in formal instruction" (Gray & Howard, 2014, p. 56).

5.5.2. Methodological considerations

The identification of theoretically relevant material and its allocation with correspondent conceptual categories proceed on the grounds of its identification

within the online environment it takes place. Information elicited from Wikis lack of a “temporal” property comparable to the one in video records, and as such incidents are not sequentially spotted and described linearly in a defined timeframe as they occur in the design studio course (i.e. 20 minute design critique sessions). Conversely, other descriptors provide grounds for the elicitation of relevant incidents, such as the design of certain navigational paths, multimodal representations and assemblies such as blocks of information (Kress, 2010), or comments-based dialogues in chat forums. As a result, a multimodal approach to the identification of theoretically relevant materials is proven useful for keeping an adequate and structured process of theoretical development, while still using a different interpretation toolkit than with those incidents elicited from the AR-mediated dialogues in **Chapter 4**.

The specific design brief and its organisational conditions (including a knowledge manager per each group of students, for instance) can be considered as fit for the purpose of this study. Likewise and as already stated, a given brief which seems to be rather constrained to specific and small-scale buildings seems to remove several complex dimensions of larger-scale buildings. As a result students deal with an “open field” for experimentation, in which time and workload allocations allow them to explore the use of new representation and communication tools, while still complying with the assigned roles for each member of the group. As a result, it has been considered relevant to point out that a controlled, accurate and specific design brief seems to be more suitable to investigate technology-driven shifts in design pedagogy, given its capacity to easily control variables such as divergent ideas and design approaches in the studio.

5.5.3. Summary and conclusions

This Chapter draws upon the observation of communication dynamics using Wikis in a design studio course. More specifically, it has addressed a series of modes of interaction that foster such communication dynamics and facilitate online communication: the use of text, the use of images, and the construction of layouts as an assembly of both text and images. The core three perspectives from which theoretically relevant material is described are: design and construction of the Wiki sites, group interactions in the Wiki sites, and studio interactions in the Wiki sites.

Observations into the detailed communication patterns have resulted into an expansion of the existing conceptual categories. After the categories have been grounded and described from the observation of face-to-face AR-mediated interactions, it has been seen that on-line interactions also provide a broader array of incidents which are relevant and applicable to those categories, strengthening their definitions by allocating new theoretically relevant material.

Additionally, as a further step into the theory construction process, it has been found that the observation of the design and construction of the Wiki sites, the group interactions in the Wiki sites, and the studio interactions in the Wiki sites, provides a mean to correlate the existing categories into emergent frameworks, such as an overall pattern that relates solo interactions with troubleshooting – suggesting that most of the troubleshooting is done individually beyond the scope of the group dynamics. Such emergent structures of correlations, even if limited on their reach and generality, are useful resources to more comprehensively describe the use of Wikis by a design studio course. Moreover, such emergent pedagogical frameworks allow to structure, observe, define or share such emergent knowledge related to the use of Wikis as a facilitating technology for design studio teaching and learning.

Recalling the objectives of this research as well as the findings of **Chapter 4**, such allocation of the conceptual categories into emergent frameworks suggests the potential understanding of multimodal on-line interaction as pedagogy, and how pedagogy is continuously and socially reshaped through the use of communication and representation resources. In that sense, the work presented here has focused on multimodality as a relevant approach to investigate the on-line environments, by describing communication dynamics based on the observation of text, images and layouts.. The use of multimodality then confirms the methodological apparatus described in Chapter 2 and complies with the second objective of this work: **to develop a multimodal research approach and its corresponding methods and tools for architectural education research**

As a result, and following the objectives of this work, the presented research stage contributes towards the completion of the third objective of this research: **to construct a series of descriptive interrelated concepts, and a subsequent framework upon which a theory of augmented pedagogies is based.**

CHAPTER VI

VALIDATION, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK

Can you briefly describe your teaching approach?

Ian: It's hard to be specific (.) they are very varied, so you have to change your approach depending on the year, the project and the students really (.) so I'd say that.

6.1. INTRODUCTION

As its core theme, this dissertation has stressed the need for a more comprehensive understanding of the roles and impacts of AR and Wiki technologies in design studio education. While this has been the main question throughout the research process, the ultimate objective of this work has been to discover, organise and formalise such impacts into a **theory of augmented pedagogies** that identifies such emergent pedagogical knowledge, and organises it into a flexible yet fully functional conceptual framework.

This research contributes towards that goal through the development of a pedagogical framework, composed of seven interrelated conceptual categories which account for the aforementioned phenomena: organisational shifts, solo interactions, social interactions, technology affordances, troubleshooting, multimodal engagement, and emotional engagement. Such framework is, however, not only descriptive. Emergent organisations and linkages across concepts have been identified and, as a result, the framework is inherently linked with its contexts of operation, it allows the accomodation of further incidents and theoretically relevant findings, and allows its users to explain and share that knowledge with others in a transferrable manner. In that sense, the main groups that benefit from this work are the academic community (design instructors and students) and technology developers.

Throughout this work, design teaching and learning has been described as a multimodal phenomenon: a social construction allowed by the coordinated assembly of various modes of communication within a social context. In that sense, unique modes of communication have been identified as relevant to observe AR and Wikis in design education, as well as to depict theoretically relevant materials, and interpret and code those meaningful distinctive situations. In order to implement such approach into the given design studio contexts, the approach of a “cognitive ethnography” has been followed, which consists on the alternate use of both experimental and ethnographic research techniques in order to unravel and understand certain cognitive process - such as learning. Multimodality has proven to be a rather pertinent approach to observe design education as communication, given their highly complex, inter-modal and inter-scalar nature. The main advantages that multimodality has posed for this research are:

- It allows to frame this dissertation in the context of contemporary shifts in design communication, such as the infusion and development of novel visualisation techniques, the shifts towards the screen as a display medium, or the complex extent to which students model, communicate, represent and visualise design knowledge with technology.
- A multimodal approach additionally allows the identification of the relevant modes of interaction that are conditioned by this research's question. In that sense, a multimodal approach shapes the rationale and fieldwork research procedures, avoiding unwanted observations, data overloads or unnecessary slices of data.
- Finally, multimodality allows a rich understanding of situations that could not be otherwise interpreted and utilised for the theoretical development. Examples of this are the construction of layouts in order to better understand the meaning-making process embedded in the Wiki sites, or the addition of gestures and actions upon models to more clearly understand design dialogues beyond its evident speech-based nature.

Some limitations have been, however, identified through the use of a multimodal approach in this research. In that sense, the detailed observation of certain modes of communication require careful planning of fieldwork activities, and some previous knowledge about the cultural cues and conventions of the design studio can greatly facilitate such participant observations. Among other challenges, are also those of multimodal density in the data. For example, the use of video recordings resulted in a fine-grained views of communication patterns, including gestural communication that greatly influenced the actions and the theory construction process. In that sense, how we do observe and record the site activities and insights from informants vary from one context to the next, which has relevant consequences on the procedural and conceptual qualities of the resulting theory.

6.2. MAIN FINDINGS

The proposed framework has been obtained after structurally sequenced steps of fieldwork research, conceptual derivation and theoretical refinement. In order to reach this goal, this thesis develops the theory of augmented pedagogies through a

series of systemically sequenced stages with their corresponding outputs. As mentioned in Chapter 3, different contexts for this research as well their radical differences have allowed to describe a series of dimensions of architectural teaching and learning, therefore enriching the scope of the resulting theory.

Firstly, a conceptual vocabulary has been created by describing the impacts of AR tools in design critique sessions, which are coded and organised into a set of seven conceptual categories. An initial analysis of the theoretically relevant slices of data contained in video recordings has revealed how dense, complex and ever-changing the communication patterns in a design studio are. Different instructional modes, design processes and products, or design tools and methods have some influence on how the actions unfold throughout a dialogue. Therefore, it has been considered as relevant that such description of AR-mediated dialogues is formalised into a series of categories:

- Solo interactions
- Social interactions
- Technology affordances
- Troubleshooting
- Emotional engagement
- Multimodal engagement
- Organisational shifts

The two core topics that organise such emergent conceptual vocabulary are those of “augmented interactions” and “pedagogic implementations of technology”. Such categories and their corresponding taxonomy set a frame of reference from which further investigation has been conducted.

A comparative analysis of relevant uses of Wiki sites for design studios has been allocated and clustered with the existing categories. The contribution of this step, in what regards to the theory outputs, is twofold: after it supported the expansion and refinement of the definition of the existing categories, it also allowed to discover correlations across those categories within three different domains in which communication using Wikis has been relevantly described:

- Design and construction of Wiki sites

- Group dynamics using Wiki sites
- Studio dynamics using Wiki sites

The linkages across conceptual categories have allowed to develop emergent relational frameworks, and a deeper understanding of how the conceptual categories are linked across each other given distinct technology-driven multimodal communication dynamics. There is evidence that contributes towards the understanding of how strong those links are, patterns of repetition and overlap across conceptual linkages and ultimately how the existing framework allows the allocation of further theoretically relevant material into the theory development process. In that sense, the proposed framework is modifiable if required by additional data and findings from other research contexts and ICT tools. Among the core findings of this stage of the research, it can be mentioned that:

- The use of AR for design critique sessions expands the array of semiotic resources available to students, given its intrinsic feature of merging both physical and digital information.
- The influence of AR and Wikis in the observed communication phenomena has allowed the elicitation of relevant dimensions of technology literacy, such as troubleshooting and knowledge related to technology affordances. As a result, it is possible to claim that students learn new communication and representation tools within their studio activities rather than in separate standardised software tutorials.
- Given the influence and control over the observed representation and communication media, students have shown a greater degree of power and authority over their design work, choosing what and how to display design information, curating their design process into multimodal and meaningful assemblies of representations. While power dynamics are out of the scope of this research, it has been shown as prevalent in educational research literature for atelier and studio-based systems (Webster, 2008).
- The understanding of multimodal communication as pedagogy has profound implications on the way students learn. While more evidence can be built to support this claim, it has been observed how seemingly insignificant actions, such as gestures or the construction of sketchy

models, greatly affects the communication dynamics, allows a better interpretation and comprehension of the message being conveyed, and at the same time allow a better conceptualisation of the communication patterns in such given contexts. Relevant examples of this are gestures that give way to the construction of the category “multimodal appropriation”, in which there is a seemingly robust link between internal and external design representations facilitated by the use of AR tools.

6.3. VALIDATION

In accordance to the developers of grounded theory (Glaser & Strauss, 1967), the validity of the theory outputs must comply with the requirements of fitness, modifiability, relevance and work. This implies that the resulting theory outputs must fit within their contexts of operation, should be modifiable upon new findings and theoretically relevant material, the results must be relevant for the intended target groups focusing on the emergent core problems or processes, and theory must work by providing explanations and interpretations of what has been observed in the area of study. This is potentially achieved by sourcing data and findings directly from the contexts of operation and users benefitting from the findings of the resulting theory.

An overall revisit of the findings of this research provide outlines to suggest the validity of the resulting outputs and findings. The resulting framework, comprised of 7 conceptual categories, fits with its contexts of operation given that has been directly grounded from incidents and situations collected from observations upon such contexts. After the analysis of online communication patterns through the use of Wikis, additional theoretically relevant materials have been added to the bulk of data considered for the theory construction. The addition of new findings to the research process has allowed to not only test the flexibility and modifiability of the resulting outputs, but to also strengthen the definition of the core concepts by adding different perspectives and methods of enquiry into the construction of the resulting framework. As a result, the existing framework is modifiable as it allows changes, expansions and further refinement as new data emerges from distinctively varied technology-mediated communication dynamics.

Given the limited previous understanding of how design studio courses react to

new ICT tools in terms of societal dynamics, and the fact that the core target group of this research is the architectural academic community, this work is relevant to the area it purposes to explain.

Finally, the resulting outputs allow to provide some explanations of how technology mediates the communication patterns of the design studio's social fabric. As stated in the Introduction of this research, these findings do not provide a full account of the whole technology-mediated learning experience, as it focuses on the tools framed within the categories of "virtual reality and 3D CAD" and the "use of web pages" (Andia, 2002) therefore leaving aside other potentially relevant areas of enquiry (e.g. repositories and databases, professional communication tools, among others). Nonetheless, it has been demonstrated that a multimodal methodology can provide our academic community with useful explanations and descriptions of related technology-related social dynamics.

6.3.1. Setting instances for the theory framework

At this last stage of the research, short interviews have been conducted with design instructors in order to better comprehend the diversity of teaching approaches and instructional standpoints throughout a School of Architecture. This allows further insights into the boundaries of applicability and generality of the framework.

Specifically, four instructors from the Liverpool School of Architecture accepted to share their views in technology-enhanced learning for this research. While this instantiation of the framework does not grant inherent generalisation to the research outputs, it serves as a way to furthermore understand the fitness of the framework in the context of specific, varied and modifiable teaching approaches. Additionally, it serves as a resource to depict how the diverging teaching approaches can be described utilising the proposed framework (instances), therefore providing a ground for further refinement of the framework and further work guidelines.

6.3.2. Characterising the interviewees

For this purpose, 4 semi-structured interviews have been conducted and the transcripts have been analysed following a text-based content analysis. All of the

informants are involved in studio teaching in either undergraduate or postgraduate studios, and their areas of expertise and teaching experience varies. Attending the ethical requirements for this stage of the research, their names have been changed for the purpose of data description. The first interviewee (**Barry**) is an experienced part-time teacher in a postgraduate architecture course. He is usually involved in design critiques, assessments and thesis supervision, while the rest of the time is devoted to his professional practice. **Noel**, the second interviewee, lectures at the Liverpool School of Architecture. He recently graduated from a postgraduate degree and is mostly involved in studio teaching in the undergraduate Architecture program. **Andy** is a young lecturer, recently arrived to the Liverpool School of Architecture. His teaching duties are focused on a postgraduate Architecture studio course. Finally the fourth interviewee, **Ian**, lectures in a postgraduate course at the Liverpool School of Architecture, together with additional thesis supervision and management duties.

6.3.3. Content analysis of responses

Content analysis has historically served a foundation for multimodal research, as it focuses on single modes of communication (e.g. text) to depict categories within large datasets (e.g. interview transcripts). In this case, since a theoretical ground has already been established by an existing group of categories, the specific mode of analysis responds to a deductive category application (Mayring, 2000) throughout the interviews.

The opening quote in this Chapter illustrates diverse perspectives and the applicability of the pedagogical framework. Overall, the construction of self-developed instructional frameworks within institutional regulations and students' specific demands has been a commonality across the interviewees. Likewise, some answers suggest some fragmentation and misunderstanding of pedagogic principles related to the use of technology (e.g. one interviewee understands learning technologies as "simulation technologies" in relation to design performance, since that is his teaching focus). The reinterpretation of pedagogic approaches based on specific teaching needs has proven to be a challenge for the content analysis, therefore large portions of transcripts have been left out of the original sample.

In order to depict the more specific compliances and intersections between their

teaching approaches and the proposed framework, a content analysis approach has been implemented by coding the relevant contents following the framework's conceptual categories. The compliance between the definition of conceptual categories and their specific approaches has proven to not always be a perfect match, but suggests that the framework can partially allocate and generally describe their teaching approaches. For instance, the following example has been transcribed from an interview, and provides interesting insights into Ian's teaching approach:

Me: Can you briefly describe your teaching approach?

It's hard to be specific (.) they are very varied, so **you have to change your approach depending on the year, the project and the students really (.) so I'd say that.**

This response suggests some shifts on the basis of student needs. While not necessarily related to technology, provides some evidence of organisational shifts within his teaching approach.

Me: But is there still some commonality on the way you treat students?

I treat them like adults, they are expected (...) There is some CAD and technology content involved in a parallel module to studio teaching (.) Although **I am not quite sure** what is taught on that side in year 3.

This response suggests a lack of engagement with the overall course curricula. Moreover, he does not seem to be aware of the CAD affordances in relation to his studio teaching requirements.

Me: But are they asked to use that knowledge in the studio?

I don't ask them to do so. In my studio there was no specific requirement (.) there was no specific requirements (.) we ask them for a series of two-dimensional and three-dimensional representations (...) **We**

This response against suggests that a clearer understanding of the technology affordances can potentially influence his teaching approach.

normally would request at least a site physical model, a physical section model (.) I think (.) in year 4 we do normally specific requests for models (-)

While not necessarily related to technology, the variety of models he describes are evidence of different modes of representation being utilised in his studio teaching approach. This is closely related to the definition of “multimodal engagement” concept.

We changed the language slightly this year because we had a student unable to make models, because (.) I cannot go into the details but **we changed the language in the brief so computer models were acceptable** (-) probably mitigating circumstances (-)

Yet again, an untold understanding of technology affordances (“what can he do with it”) allows him to provide a different teaching approach for a student with different needs.

(-) for me, my approach is to prepare people to eventually become architects and (.) really they got to look to all techniques as simple tools (-) any technique would not replace good design or bad design (-) whatever tool they use, it shouldn’t hold them back

Me: Have you been in the need to incorporate certain tools to the design studio?

For me it’s actually the opposite, Sketchup is a really bad tool (.) is not a bad tool (.) **but it is bad in the wrong hands** (.) I think its partly (.) **students who are not fully capable of those techniques will hide under that technique** (.) not really considering the construction (-)

This value judgement suggests some emotional response to the use of certain technology (“emotional engagement”) while it also acknowledges that a sensitive use of it can actually augment a design. On the other hand, tutorials and troubleshooting seem necessary as students engage with it in varied ways.

As seen, the instructor has not directly addressed the conceptual categories built

within this research, but has raised some interesting comments that relate his teaching approach to some concepts in varied ways. For instance, he seems to understand that a more comprehensive engagement with certain technology in the context of his teaching practice can provide students with a useful design tool, or he acknowledges that troubleshooting affects students in different ways (either not being capable of using a 3D modelling tool, or purposefully using it to meet a student's specific needs).

This early “coding” process is able to identify those topics throughout the interviews and relate them with the existing categories, such as “troubleshooting”, or “technology affordances”. After such types of content analysis, the relevant answers from instructors are mapped upon the existing framework to visualise their teaching approach in relation to the existing available categories (Figure 6.1).

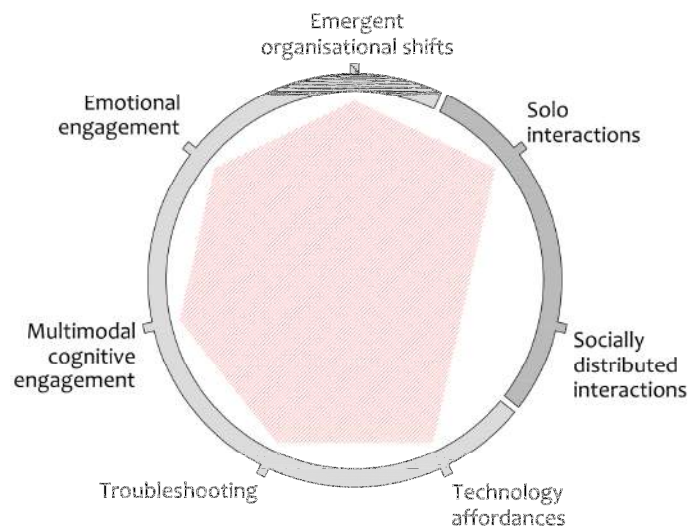


Figure 6.1. Diagram of the applicability of the framework to Ian's teaching approach.

As seen, this early exploration does not intend to frame diverse teaching approaches into a framework, but to provide some early explanations to understand and describe their teaching approaches. The analysis of the 4 interviews overall (Figure 6.2) tells us that their approaches vary, their understanding of technology changes individually and that variety, instead of challenging the results of this work, provide a ground for further exploration, expansion, refinement and modification of the resulting framework on the basis of additional data, methods

and participants.

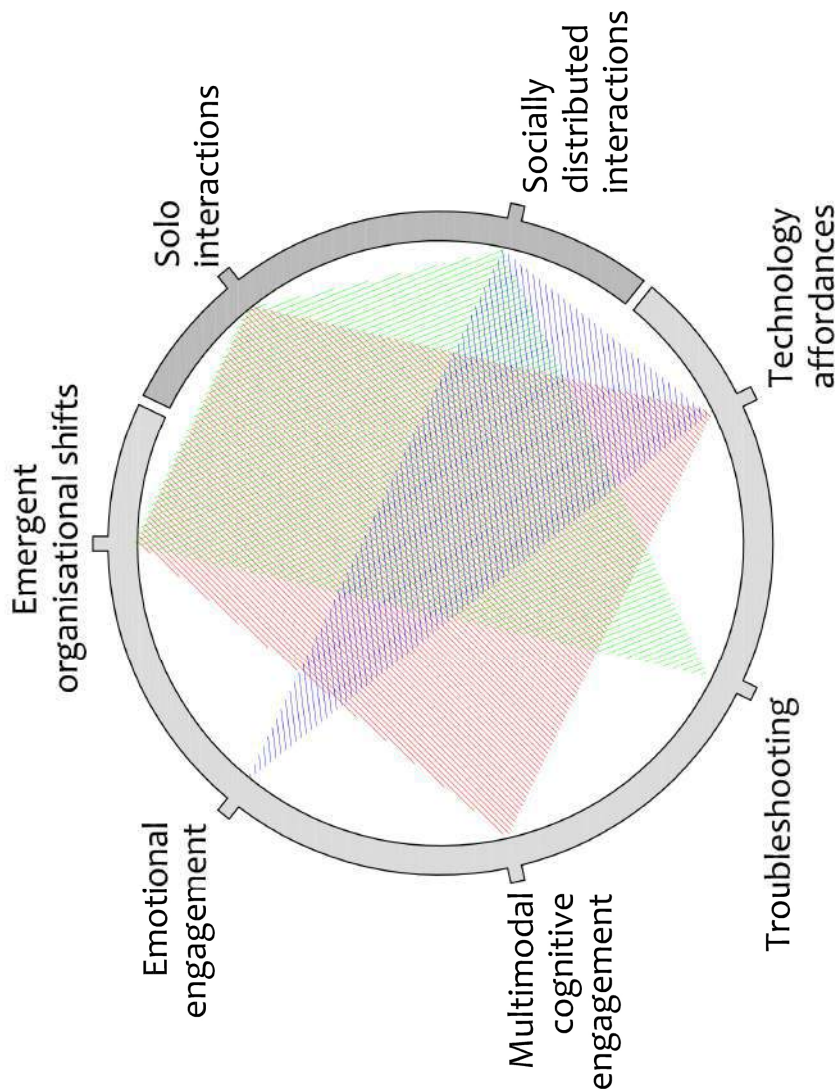


Figure 6.2. Diagram of the applicability of the framework to Noel's (red), Barry's (green) and Andy's (blue) teaching approaches.

6.4. APPLICABILITY OF THE FRAMEWORK

As graphically shown, the framework allows to describe the different teaching approaches in relation to technology-enhanced learning. Every instructor has a different understanding, knowledge and preferences that shape the way technology impacts on their studio teaching.

Some of the results are rather relevant for this work. It is pertinent to point out, for example, that technology affordances seems to be a prevalent element in their various teaching approaches – what can they do with technology in their studios?. Likewise, interactions with technology (either solo or social) have been usually present in their answers, whereas not every category related to a pedagogic implementation of technology (e.g. emotional or cognitive engagement) seemed to be always part of their teaching approach, contradicting the density of these categories found in previous stages of this research process.

Nevertheless, the proposed framework proved useful to map the extents of such diverse approaches. Findings indicate that those contexts of application are nowadays individually built by design instructors within rather loose institutional frameworks and codes of practice, sometimes conveniently adapted and re-shaped in accordance to specific students' requirements. All of them, within their diversity of perspectives, have declared their own construction of emergent pedagogies and insights in regards to students' feedback, some understanding of technology-enhanced learning and the role they assign to technologies for teaching and learning purposes – specifically focused on troubleshooting and an understanding of the affordances of different technologies. Then, the diversity of approaches challenges the applicability boundaries of the theory framework and requires further work towards its full clarification.

6.5. MAIN CONTRIBUTIONS OF THE RESEARCH

Following the original objectives of this work, this research contributed to knowledge in the fields of technology enhanced learning and architectural education. Contributions from this work has been anticipated as both theoretical and methodological:

- Development of a conceptual vocabulary (categories) - a set of grounded and organised vocabulary to describe the observed phenomena.
- Development of pedagogical frameworks (a model) - by mapping distinct multimodal communication patterns to establish the linkages, and their intensity across the components of the conceptual vocabulary.
- Development of scenarios to explore the validity and applicability boundaries of the framework (instances).

- Construction and testing of a set of research methods (a methodological apparatus) to address the observed phenomena from a multimodal perspective.

6.5.1. General contribution to architectural design education

The representation of multimodal communication in design studio education presented in this work is formalised into a set of theoretical contributions. As a result, such knowledge can be now shared and transferred, and it is expected a primary contribution towards the education of new architects. In that sense, a deeper understanding of how pedagogy and communication are related, and how those linkages can structure pedagogical approaches, are foundational pieces of knowledge to establish technology-mediated learning situations such as technology infusion into a design studio. Moreover, the observed organisational shifts allow a more active role of students in their own education, empowering them to gain control and decision-making drivers throughout their design process. It is relevant, in that sense, to recall that no students received any type of incentive to participate in this research. As a result, the infusion of representation and communication tools into design studio courses has motivated students enough to become informants of this work, learn new ICT resources for their work, and comprehend the extent of complexity to which they perform in the design studio.

6.5.2. General contribution to design research

This research additionally aims to contribute towards social semiotics and communication studies, and to design research in general. It can be anticipated that a grounded theory approach, as well as the introduction of multimodality as a research approach with an associated toolkit of research methods, will contribute to the understanding of the impacts and roles of technology in design studios. This research is focused on the societal patterns of communication situated in a cultural context - that of the design studio. In that sense, communication patterns - the source of the knowledge derived from this research - are distributed and socially constructed phenomena, continuously shifting across modes of communication and their corresponding semiotic resources and inter-modal assemblies.

6.6. RECOMMENDATIONS FOR FURTHER WORK

While more empirical evidence will be required to strengthen and reinforce the framework's depth and scope, it can be argued that it is still a relevant and important first step. Its relevance lies on the fact that accounts for two distinctive learning situations that greatly influence design studio education: design critique sessions, and students' informal work outside teaching hours. However, empirical validation and a further elaboration of concepts in other settings are needed, such as in design juries sessions, or the elaboration of design brief, both also important tenets of the design studio culture. In that regard, such additional factors might influence the way we understand technology-mediated communication in design studios. For instance, jury sessions usually involve a marking component (summative feedback) whereas the design brief conditions the modes of production and organisation of the design studio. Such factors are not considered as part of this research.

Secondly, it is necessary to focus on broader arrays of modes of communication. By now, the modes of communication have been selected in accordance to the research objectives and the local conditions upon which technology has been utilised throughout the research. However, more detailed analyses of additional modes of communication, their assemblies and orchestrations (e.g. gaze, pitch and tone of voice, use of moving images through Wikis, among others) can provide further insights to sharpen the proposed concepts. A consideration into more detailed modes of communication, together with its associated set of research methods, would facilitate the interpretation of communication dynamics. Work can be anticipated in a series of topics such as additional relevant modes of interaction (new emergent modes of representation and dissemination, for instance). Additionally, while the relationships across media, learning and cognition are not new (Salomon, 1979), shifts in the pedagogic landscape and media literacies have been identified as relevant domains of multimodal studies (O'Halloran & Smith, 2011). The use of technologies for learning and teaching can be now observed from a socio-cultural perspective. In that sense, the observation of technologies in educational contexts have led social scientists to raise interesting research issues across observed settings, such as identity, power, gender, ability, or text-making throughout learning processes (Jewitt, 2011).

Lastly, further work can be proposed on the interpretative contexts that shape the research process, and particularly that of coding. This work made use of a scaffolding of research methods in order to provide a sufficient understanding of the participants' backgrounds, digital literacies, control over certain tools, or design approaches and preferences. Communication, nevertheless, takes place within culturally shaped contexts and as such, it is greatly defined by the cultural and social backgrounds of different informants, including both students and instructors. However, integrating these conditions in a future analysis would likely require more multidisciplinary collaboration across the fields of cultural studies, anthropology and educational research.

LIST OF REFERENCES

- Akin, O. (1990). Computational design instruction: toward a pedagogy. In M. McCullough, W. J. Mitchell, & P. Purcell (Eds.), *The Electronic Design Studio: Architectural Knowledge and Media in the Computer Era* (pp. 302-316). Cambridge: MIT Press.
- Andía, A. (2002). Reconstructing the effects of computers on practice and education during the past three decades. *Journal of Architectural Education*, 56, 7-13.
- Atkinson, J. M., & Heritage, J. (1984). *Structures of social action*. Cambridge: Cambridge University Press.
- Atkinson, P., & Hammersley, M. (1994). Ethnography and participant observation. *Handbook of qualitative research*. Thousand Oaks, CA: Sage.
- Balbo, R., Kocaturk, T. & Veliz, A. (2013). Hybrid architecture: Coupling structural understanding and architectural education. *Proceedings of the 2nd International Conference in Architecture and Structures, Portugal*.
- Belcher, D., & Johnson, B. (2008). MxR: A Physical Model-Based Mixed Reality Interface for Design Collaboration, Simulation, Visualization and Form Generation. *Proceedings of the 28th ACADIA Conference* (pp. 464-471).
- Bezemer, J., Cope, A., Kress, G., & Kneebone, R. (2011). "Do you have another Johan?" Negotiating meaning in the operating theatre. *Applied Linguistics Review*, 2, 313-334.
- Bezemer, J., Cope, A., Kress, G., & Kneebone, R. (2014). Holding the scalpel: Achieving surgical care in a learning environment. *Journal of Contemporary Ethnography*, 43, 38-63.
- Boyer, E. L., & Mitgang, L. D. (1996). *Building Community: A New Future for Architecture Education and Practice. A Special Report*. California Princeton Fulfillment Services.
- Bowen, G. (2006). Grounded theory and sensitizing concepts. *International Journal of Qualitative Methods*, 5(3), 12-23.
- Breen, J. (2002). Design driven research.. In T.M. De Jong & D.J.M. Van Der Voordt (Eds), *Ways to study and research urban, architectural and technical design* (pp. 137-146). Netherlands: Delft University Press.
- Brown, A. (2003). Visualization as a common design language: connecting art and science. *Automation in Construction*, 13, 703-713.
- Brown, A., Knight, M., Winchester, M. (2007). An architectural learning environment - predicting the future. *Proceedings of the 25th eCAADe Conference*, (pp. 671-675).
- Buechner, J. (2011). Fictional entities and augmented reality: A metaphysical impossibility result. *Journal of Evolution & Technology*, 22 (Minds and Machines Special Issue), 53-72.
- Catalano, F. (1990). The computerized design firm. In M. McCullough, W. J. Mitchell, & P. Purcell (Eds.), *The Electronic Design Studio: Architectural Knowledge and Media in the Computer Era* (pp. 317-332). Cambridge: MIT Press.

- Charmaz, K., (2006). *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. London: SAGE.
- Cross, N. (2001). Design cognition: results from protocol and other empirical studies of design activity. In C. Eastman, W. Newstatter & M. McCracken (Eds.), *Design knowing and learning: cognition in design education* (pp. 79-103). Oxford: Elsevier.
- Cuff, D. (1991). *Architecture: The Story of Practice*. Cambridge: MIT Press.
- Danahy, J. (1991). The computer-aided studio critic: gaining control of what we look at. *CAAD Futures '91 Conference Proceedings*, (pp 121-138).
- Domingo, M., (2012). Linguistic layering: social language development in the context of multimodal design and digital technologies. *Learning, Media and Technology*, 37(2), 177-197.
- Domingo, M., Jewitt, C. and Kress, G. (In Press). Multimodal social semiotics: Writing in online contexts. In K. Pahl and Rowsel (eds.) *The Routledge Handbook of Contemporary Literary Studies*. London: Routledge.
- Dreyfus, H. (1992). *What computers still can't do: a critique of artificial reason*. Cambridge: MIT Press.
- Dutton, T.A. (1987). Design and studio pedagogy. *Journal of Architectural Education*, 41(1), 16-25.
- Eisenhardt, K.M. (1989). Building theories from case study research. *The Academy of Management Review*, 14(4), 532-550.
- Ericsson, K.A., & Simon, H. (1980). Verbal reports as data. *Psychological Review*, 87(3), 215-251.
- Falthin, A. (2011). *Musik som nav i skolredovisningar* (Thesis). Retrieved from Academic Archive On-Line repository.
- Flewitt, R., Hampel, R., Hauck, M., & Lancaster, L. (2014). What are multimodal data and transcription? In: Jewitt, Carey (ed.) *The Routledge Handbook of Multimodal Analysis (2nd edition)*. London: Routledge, pp. 44-59.
- Freilich, M. (1970). *Marginal natives: Anthropologists at work*. New York: Harper & Row.
- Gero, J. S. (1990). A locus for knowledge-based systems in CAAD education. In M. McCullough, W. J. Mitchell, & P. Purcell (Eds.), *The Electronic Design Studio: Architectural Knowledge and Media in the Computer Era* (pp. 49-60). Cambridge: MIT Press.
- Gero, J. & McNeill, T. (1998). An approach to the analysis of design protocols. *Design Studies*, 19(1), 21-61.
- Geertz, C. (1973). *The interpretation of cultures: Selected essays*. Basic Books.
- Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory*. Chicago: Aldine.
- Glaser, B. G., (1992). *Basics of grounded theory analysis: Emergence vs. forcing*. California: The Sociology Press.
- Glaser, B. G., (1998). *Doing Grounded Theory*. California: The Sociology Press.

- Goldschmidt, G., (1997). Capturing indeterminism: representation in the design problem space. *Design Studies*, 18(4), 441-455.
- Goldschmidt, G. (2003). Expert knowledge or creative spark? Predicaments in design education. In N. Cross, E. Edmonds (Eds.), *Expertise in Design* (pp. 221-233). Sydney: University of Technology Sydney.
- Hamel, R. (1990). *Over het denken van de architect: een cognitief psychologische beschrijving van het ontwerpproces bij architecten*. Amsterdam: AHA Books.
- Hamel, R., (1995). Psychology and design research. In M.F.T. Bax, R.M. Oxman, & H.H. Achten (Eds.), *Proceedings of the Symposium "Design research in the Netherlands"* (pp. 49-59).
- Heath, C., Hindmarsh, J., & Luff, P. (2010). *Video in qualitative research: analysing social interaction in everyday life*. London: SAGE.
- Heller, F., (2001). Towards a socio-ecotechnology. *Journal of Engineering and Technology Management*, 18, 295–312.
- Hodge, R. & Kress, G. (1988). *Social semiotics*. Cambridge: Polity.
- Hollan, J., Hutchins, E., & Kirsh, D. (2000). Distributed cognition: toward a new foundation for human-computer interaction research. *ACM Transactions on Computer-Human Interaction*, 7(2), 174-196.
- Hsiao, C. and Johnson, B. (2011). TiMBA – Tangible User Interface for Model Building and Analysis. In J.A. Jacko (Ed.): *Human-Computer Interaction, Part II, HCII 2011*, (pp. 43–52).
- Hutchins, E. (1995). *Cognition in the wild*. Cambridge: MIT Press.
- Hutchins, E & Klausen, T. (1996) Distributed cognition in an airline cockpit. In Y. Engestrom and D. Middleton (Eds.) *Cognition and communication at work*. New York: Cambridge University Press. pp. 15-34.
- Jefferson, G. (2004). Glossary of transcript symbols with an introduction. In G. Lerner (Ed.), *Conversation analysis: Studies from the first generation* (pp. 13-31). Amsterdam/Philadelphia: John Benjamins.
- Jewitt, C. (Ed.), 2009. *The Routledge handbook of multimodal analysis*. New York: Routledge.
- Jewitt, C. (2011). The changing pedagogic landscape of subject English in UK Classrooms. In K. L. O'Halloran, B. A. Smith (Eds.), *Multimodal studies: exploring issues and domains* (pp. 184-201). New York: Routledge.
- Jewitt, C. (2012). *An introduction to using video for research*. London: MODE, National Centre for Research Methods.
- Jewitt, C. (2013). Multimodal methods for researching digital technologies. In S. Price, C. Jewitt & B. Brown (Eds.), *The SAGE Handbook of Digital Technology Research*. London: SAGE.
- Knight, M. & Brown, A., (2010) Increasing Design Reflection and Improving Feedback using Wikis. *28th eCAADe Conference Proceedings, Switzerland*.

- Kocaturk, T. (2006). *Modelling collaborative knowledge in digital free-form design* (PhD Dissertation). Retrieved from the institutional repository of the Delft University of Technology.
- Kocaturk, T., Agkathidis, A., Veliz, A., Qabshoqa, M., 2014. *Reflective and dynamic use of Wikis to support collaborative design learning*. Retrieved from <http://www.designpedagogy.org>
- Kocaturk, Balbo, Medjdoub & Veliz, 2012 - An innovative approach to technology mediated architectural design education: A framework for a web-based socio-cognitive ecosystem. In: *30th International Conference on Education and Research on Computer--Aided Architectural Design in Europe (eCAADe) 2012, Czech Republic*.
- Kolb, D., (1985). Learning styles inventory. *The Power of the 2x2 Matrix*, 267.
- Kress, G. & van Leeuwen, T. (1996). *Reading images: the grammar of visual design*. London: Routledge.
- Kress, G. & van Leeuwen, T. (2001). *Multimodal discourse: The modes and media of contemporary communication*. London: Hodder Education.
- Kress, G. (2010). *Multimodality: A social semiotic approach to contemporary communication*. London: Routledge.
- Lawson, B. (2005). *How designers think: the design process demystified* (4th ed.). Oxford: Elsevier/Architectural Press.
- Lawson, B. (1994). *Design in mind*. Oxford: Architectural Press.
- Lindquist, M. (2006). Web Based Collaboration (for Free): Using Wikis in Design Studios. In G. Luhuan, P. Anzalone, M. Cabrinha & C. Clarke (Eds.) *Synthetic Landscapes. Proceedings of the 25th Annual Conference of the Association for Computer-Aided Design in Architecture*. (pp. 190-199).
- Lomax, H., & Casey, N. (1998). Recording social life: reflexivity and video methodology. *Sociological Research Online*, 3(2), Published online: <http://www.socresonline.org.uk/3/2/1.html>
- Luff, P., & Heath, C. (2012). Some 'technical challenges' of video analysis: social actions, objects, material realities and the problems of perspective. *Qualitative Research*, 12(3), 255-279.
- March, S.T. & Smith, G.F. (1995). Design and natural science research on information technology. *Decision Support Systems*, 15(1995), 251-266.
- Mayer, R., (2008). Multimedia literacy. In J. Corio, M. Knobel, C. Lankshear, & D. Leu (Eds.), *Handbook of Research on New Literacies* (pp. 359-376). New York: Erlbaum.
- Mayring, L. (2000). Qualitative content analysis. *Forum* 1(2).
- McCollough, M., Mitchell, W., & Purcell, P. (Eds.). (1990). *The Electronic Design Studio: Architectural Knowledge and Media in the Computer Era*. Cambridge: MIT Press.
- McNeill, T & Gero, JS (1998) An approach to the analysis of design protocols, *Design Studies* 19(1): 21-61

- Mewburn, I. (2009). *Constructing Bodies: Gesture, Speech and Representation at Work in Architectural Design Studios* (PhD dissertation). Retrieved from the institutional digital repository of the University of Melbourne.
- Mewburn, I. (2011). Lost in Translation: reconsidering reflective practice and design studio pedagogy. *Arts and Humanities in Higher Education*, 11(4), 363-379.
- Mizban, N., & Roberts, A. (2006). The place of e-learning in architectural education - a critical review. *Proceedings of the 24th eCAADe Conference*, Greece.
- Mizban, N. & Roberts, A. (2008). *A review of experiences of the implementation of e-learning in architectural design education*. Cardiff: Centre for Education in the Built Environment.
- Moura, H.T. (2008). *A methodological framework for bringing multimodality and affordances to design of technology-enhanced learning environments*. (PhD Dissertation). Retrieved from the institutional repository of the Illinois Institute of Technology.
- Murphy, K., Ivarsson, J., & Lymer, G. (2012). Embodied reasoning in architectural critique. *Design Studies*, 33(6), 530-556.
- Oh, Y., Ishizaki, S., Gross, M., Yi-Luen Do, E. (2013). A theoretical framework of design critiquing in architecture studios. *Design Studies*, 34(3), 302-325.
- O'Halloran, K., & Smith, B. (Eds), (2011). *Multimodal studies: exploring issues and domains*. London: Routledge.
- Ochsner, K. N. (2000). Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General*, 129, 242-261
- Orlikowski, W. & Iacono, C.S. (2001). Research commentary: Desperately seeking the "IT" in IT research - a call to theorizing the IT artifact. *Information Systems Research*, 12(2), 121-134.
- Purcell, P. & Appelbaum, D. (1989). Light Table: An interface to visual information systems. In McCollough, M., Mitchell, W., & Purcell, P. (Eds). (1990). *The Electronic Design Studio: Architectural Knowledge and Media in the Computer Era* (pp. 229-238). Cambridge: MIT Press.
- Purcell, A.T. & Gero, J. (1998). Drawings and the design process. *Design Studies*, 19, 389-430.
- Sakr, M., Jewitt, C., & Price, S. (2014). The Semiotic Work of the Hands in Scientific Enquiry. *Classroom Discourse*, 5(1), 51-70.
- Salomon, G. (1979). *Interaction of media, cognition and learning - An exploration of how symbolic forms cultivate mental skills and affect knowledge acquisition*. California: Jossey-Bass.
- Salomon, G. (1993). *Distributed Cognitions: Psychological and educational considerations*. Cambridge: Cambridge University Press.
- Schön, D. (1983). *The Reflective Practitioner: How professionals think in action*. Basic Books.
- Schön, D. (1985). *The Design Studio: an exploration of its traditions and potentials*. London: RIBA Publications.

- Schön, D. (1988). Towards a marriage of artistry & applied science in the architectural design studio. *Journal of Architectural Education*, 41(4), 4-10.
- Shulman, L. (2005). Signature pedagogies in the professions. *Daedalus*, 134, 3, 52-59.
- Simmonds, R. (1978). *Learning to learn and design: The development of effective strategies in a graduate School of Architecture*. (PhD Dissertation). Retrieved from the institutional repository of the Massachusetts Institute of Technology.
- Simon, H. (1969). *The sciences of the artificial*. Cambridge: MIT Press.
- Stevens, G. (1995). Struggle in the Studio: A Bourdivin Look at Architectural Pedagogy. *Journal of Architectural Education*, 49(2), 105-122.
- Strauss, A., & Corbin, J., (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. London: SAGE.
- Till, J. (2005). Lost Judgement. In E. Harder (Ed.), *EAAE Prize 2003-2005 Writings in architectural education* (164-181). Copenhagen: EAAE.
- Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the long-wall method of coal-getting. *Human Relations*, 4, 38.
- Unsworth, L. & Cleirigh, C. (2009). Multimodality and reading: the construction of meaning through image-text interaction. In C. Jewitt (Ed.), *The Routledge Handbook of Multimodal Analysis* (pp 151-163). London: SAGE.
- Van Leeuwen, T. (2005). *Introducing social semiotics*. New York: Routledge.
- Vowles, H., Low, J. & Doron, H. (2012). Investigating architecture studio culture in the UK: A progress report. *Journal for Education in the Built Environment* 7(2): 26-49.
- Wagner, C. (2004). Wiki: A technology for conversational knowledge management and group collaboration. *Communications of the Association for Information Systems*, 13, Article 19.
- Wang, X., Gu, N. & Marchant, D. (2008). An empirical case study on designer's perceptions of augmented reality within an architectural firm. *Journal of Information Technology in Construction*, 13 (Special Issue Virtual and Augmented Reality in Design and Construction), 536-552.
- Ward, A. (1990). Ideology, culture and the design studio. *Design Studies*, 11(1), 10-16.
- Webster, H. (2005). The architectural review: A study of ritual, acculturation and reproduction in architectural education. *Arts and Humanities in Higher Education*, 4(3), 265-282.
- Webster, H. (2008). Architectural Education after Schön: Cracks, Blurs, Boundaries and Beyond. *Journal for Education in the Built Environment*, 3(2), 63-74.

APPENDIX I

Veliz, A. (2013). Augmented modelling in the design studio: Augmented pedagogies.
Augmented reality, art and technology, 3, 58-63.

AUGMENTED MODELLING IN THE DESIGN STUDIO: AUGMENTED PEDAGOGIES

ALEJANDRO VELIZ REYES
University of Salford

DIGITAL PHYSICALITY / PHYSICAL DIGITALITY

From very early stages of the design process (sketches and diagrams) up to detailing and construction, models are built by using several different — yet interrelated techniques. The construction of a physical model by computer-controlled machinery requires, unavoidably, a digital counterpart. Likewise, scanning and reverse engineering methods allow a fluent interaction between models which embeds information and knowledge as the design process proceeds. As a result, a complex orchestration of users, developers, tools and techniques merge into tailored modelling flow works according to each project's requirements. This design-technology synchronic co-evolution has been historically aligned with the *zeitgeist* of the architectural practice, in which new technological developments shape the way we express ourselves, and define new design forms and organizational/social schemes.

*...augmented reality now
gives us the chance to build
hybrid, augmented models.*

Indeed, this section is titled with the topic of the latest conference of the Association of Education and Research on Computer Aided Architectural Design in Europe (eCAADe) held at the Czech Technical University in Prague (September 2012):

Digital physicality, Physical digitality. One of the main grips in which this topic is grounded is that the growing academic concern on the dialogs between physical and digital realms in architecture is becoming blurry, since the distinction between both cannot be fully depicted in a world where digital information is continuously embedded into 'real world' situations, such as ubiquitous computing systems or environmentally responsive technologies. This recent conference had, so far, the biggest amount of published articles in the history of the eCAADe Association Conference, and further evidence of this trend is the growing participation of architects and designers in professional events such as Ars Electronica, SIGGRAPH or the ISMAR community.

This work claims that beyond physical or digital modelling techniques, augmented reality now gives us the chance to build hybrid, augmented models. Augmented models are those which blend a physical and a digital counterpart in a resulting synchronic manner, hence taking advantage of the benefits of physical modelling methods (dexterity skills, manipulability) as well as digital (accuracy, modifiability, among others). Also, in addition to the technical definition of augmented reality, the concept of augmentation has a major role in this work. Even if the semantics of augmentation suggests an 'increment on size or amount', it also



TRAINING SESSION ON AUGMENTED REALITY AUTHORIZING AND AUGMENTED MODELLING,
SCHOOL OF THE BUILT ENVIRONMENT, UNIVERSITY OF SALFORD.

suggests some enhancement. As a result, this approach to the augmentation of reality fits with the major aim of educational research which is to enhance and improve educational processes and methods, thus naming this work as '*Augmented Pedagogies*'.

MODELS IN THE DESIGN STUDIO

"It looks better like this", says an architectural design instructor while chopping a piece of cardboard off a building model. In the same *design crit* session, students, instructors and observers engage in a dialog based on the use of plans and sections, rendered views of a project, physical mock-ups,

diagrams and sketches. This scenario might not be unknown for any architecture student, since the studio teaching scheme has been largely acknowledged as the core practice-based module in which both design (composition, planning, representing) and high-order cognitive skills (critical thinking, analysis, synthesis) are mainly developed in architectural education programs around the world. Actually, the architecture studio and its interactions as a subject matter is a quite complex challenge. As stated by Allen Cunningham in 2005, after a centennial adaptation and evolution the studio teaching scheme and "*project-based education around architecture employing the studio system is the most advanced method of teaching complex problem solving that exists*".

The usefulness of models within the design studio is clear. Beyond the fact that its construction itself entails the development of technical skills, models also embed design information and knowledge, affecting organizational dynamics (the design critique or peer to peer collaborative work), the creation of students' 'toolkits' or the final presentation of the design solutions, among other benefits. During this research being conducted at the University of Salford (UK), the extent of the impact of augmented models in this complex studio-system is yet to be depicted. Augmented models will be used, therefore, as a way to understand how new technologies impact design education and how can we describe that impact

from a scientific research perspective, that is following the guiding principles of generalizability, communicability and transferability of that resulting knowledge.

The deep impact of new digital tools in design pedagogy has been explored recently by design theorists, such as Dr Rivka Oxman. The particularity of the design studio as a research setting is spiced by theoretical underpins that can potentially lead the path to depict this impact. For example, it has been stated that the studio teaching is usually an unstructured process, in which perceptions and interpretations of information and models play a major role in the students'



progression in the courses, mostly based on 'design dialogs' between students, and students and instructors. Also, digital tools have the potential to not only re-shape the toolkits being used for design, but also mediate in the way design methods are structured, offers new 'digital materials' to work with or changes the very nature of the design problems to be faced in different courses.

It is not clear, however, how this impacts occurs. The interactions within the studio that make use of representations and models to design are well established '*rituals*' such as peer-to-peer collaborative activities or the design critique, but the nature of each studio differs from each other. Variables such as the experience of the instructors, the background of the students, the nature of the design problems to be faced or the institutional standpoint turn the studio into highly context-dependant modules. As a result those variables are usually highly controlled and the study of the impact of different technologies is commonly constrained to the description of technical challenges to be solved, the development of new systems/software or metrics of student satisfaction, rather than on the provision of a theoretical account of their impact into this complex teaching/learning process. The lack of a theory that describes how technology re-shapes the studio results in very limited knowledge re-usability and in turn, into very caged and localized pedagogical frameworks that do not allow cross-institutional or cross-disciplinary collaboration, to evaluate the constant infusion and evolution of new digital tools for educational purposes or to re-use a pedagogical approach and its associated knowledge.

A THEORETICAL APPROACH TOWARDS AUGMENTED PEDAGOGIES

Indeed, there is not fixed methodology to study the impact of digital technologies in design education. Rather, each study requires an own



IMAGES OF THE TRAINING SESSIONS ON AUGMENTED REALITY AUTHORIZING AND AUGMENTED MODELLING. STUDENTS OF THE PROGRAMS MSC DIGITAL ARCHITECTURAL DESIGN AND MSC BUILDING INFORMATION MODELLING AND INTEGRATED DESIGN, SCHOOL OF THE BUILT ENVIRONMENT, UNIVERSITY OF SALFORD.



standpoint in terms of validity and fitness to the research problem and the subject matter. As Wanda Orlikowski and Suzanne Iacono (2001) state on their work on information systems theory research, this corresponds to the fact that the use of technologies depend on the context and hence, *“there is no single, one-size-fits-all conceptualization of technology that will work for all studies. As a result, IS researchers need to develop the theoretical apparatus that is appropriate for their particular types of investigations, given their questions, focus, methodology, and units of analysis.”*

In order to overcome this challenge, this ongoing research proposes a theoretical approach to depict the impact of augmented models in design education. By following a grounded theory methodology, observations and recordings are being collected in diverse settings on an attempt to de-

scribe the resulting studio dynamics by using augmented models. Several trainings on augmented reality and augmented modelling have been made at the University of Salford (MSc Digital Architectural Design, MSc in Building Information Modelling and Integrated Design), and two more experimental settings are now being arranged in different European countries. These multiple settings are not only intended to provide a wide view of the subject being studied, but also fits with the current recommendations for theory construction methodologies, since the manipulation and observation of data in many divergent ways and the juxtaposition of different conflicting realities and sources counteracts the tendency of reaching false or incomplete results, or information-processing biases of the investigator. ■

This work is expected to be finished by end-2014.



VIEW OF THE STUDENTS' TOOLKIT DURING THE FIRST AR WORKSHOP AT THE UNIVERSITY OF SALFORD.

RELATED LITERATURE AND SOURCES

- Achten, H., Pavlicek, J., Hulin, J., Matejdan, D. (Eds.). (2012). Digital Physicality / Physical Digitality - Proceedings of the 30th eCAADe Conference - Volume 1 / 2. Czech Technical University in Prague, Faculty of Architecture (Czech Republic) 12-14 September 2012.
- Buechner, J. (2011). Fictional Entities and Augmented Reality: A Metaphysical Impossibility Result. *Journal of Evolution & Technology*, 22(Minds and Machines Special Issue), 53-72.
- Cunningham, A. (2005). Notes on education and research around architecture. *The Journal of Architecture*, 10(4), 415-441.
- Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, 14(4), 532-550.
- Orlikowski, W. J., & Iacono, C. S. (2001). Research commentary: Desperately seeking the "IT" in IT research—a call to theorizing the it artifact. *Information systems research*, 12(2), 121-134.
- Oxman, R. (2008). Digital architecture as a challenge for design pedagogy: theory, knowledge, models and medium. *Design Studies*, 29(2), 99-120.

Alejandro Veliz Reyes

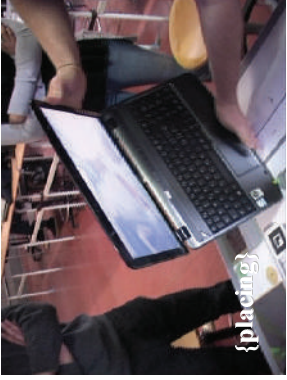
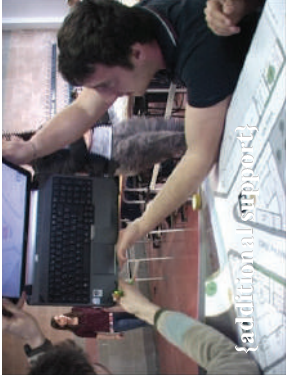




I finished my Architecture degree in 2007, in Chile. Today I am a teaching assistant and PhD student on digital architectural design at the University of Salford (United Kingdom) and my current research interests are design pedagogy, augmented reality, and collaborative technologies for design.

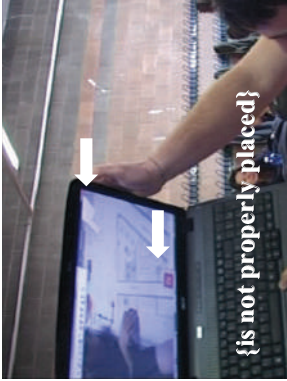

I have been involved in research activities since 2007, but my background is quite mixed and has involved the domains of sustainable design, buildings in extreme/cold environments, mass customization and digital design. My published work has led me to present on conferences and invited lectures in Chile, United Kingdom, Italy, Belgium, Slovenia, Czech Republic, Canada, among others.

APPENDIX II




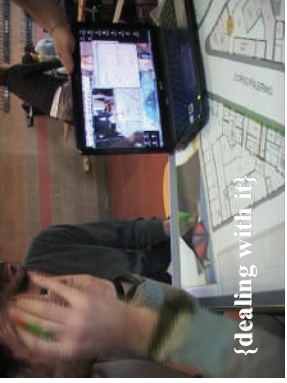
Transcripts of design critique dialogues making use of AR technology, and detail of coded incidents isolated from the data transcripts.

Group 1 – AR-based dialog 1 (00:01:20)



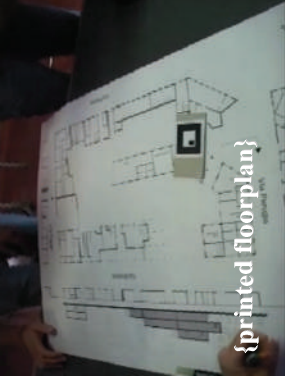

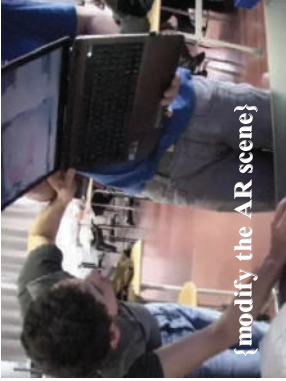
Dialog		Gestures	{Screenshot}	
	---Beginning of the dialog---			
I1	Ok, up (4)	Student begins by {placing} the laptop's webcam on an appropriate position to visualize the marker on the top of a printed floorplan. With {additional support} the instructor} he begins to explain the project.		
S1	So, we have tried to highlight the distinctive character of the (.) of the (.) (tradition) (.) with this building, based on the only point in all this square. We haven't seen a space where every building	Student adjusts the laptop during the pause. S1 {points} the screen. "Point" is referred to a plan view of the building, of pointy-like shape.		
I1	But this is an image that you are using to show this (.) is not	I1 {points at screen} as the mean to place an image. In the meantime S2 {moves some markers} in the space in front of the camera.		
S1	Yeah, it is difficult (.) to associate a model			
I1	Because you could have placed the image here [S1:the slope is always different so] (.)Yes because you could (- way out)	S2 {moves the markers around} in front of the camera. I1 {points at the printed sheet}.		
S1	Yes yes, only that (.) But as a first time is still going well (8)	{Both S1 and I1 hold again the laptop} in order to visualize the models properly on the top of the floorplans. Student stops talking and laughs at the situation. The pause of 8 seconds is due to I1		
S1	(-)			






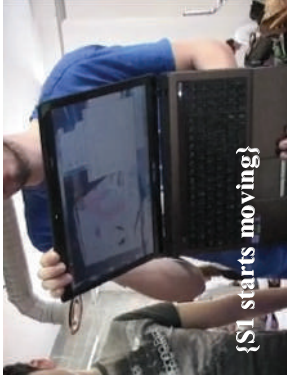
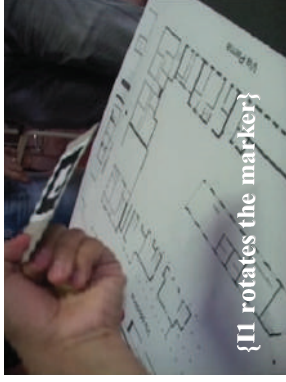

I1	Ah, is in the wrong place	checking the model on the screen. I1 realizes that the model {is not properly placed} according to the marker's coordinate system.	
S1	Now (.) the limit of the computer		
I1	I will hold the computer, come on	S1 tries to push a key in the laptop and the computer almost fell. The rest of the group of student laugh at the situation, they stop the critique for a couple minutes to do some technical adjustments in the AR model.	
	---End of the dialog---		



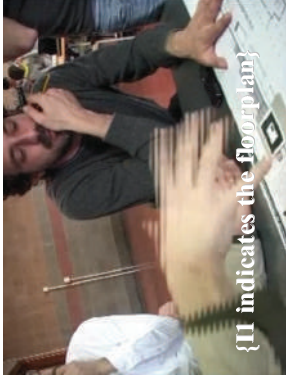



Group 1 – AR-based dialog 2 (00:00:41)


Dialog	Gestures	{Screenshot}
---Beginning of the dialog---		
S1 because it is useful as a solution but		 {I1 points at the plan view}
I1 No, no, because you can have (an attempt) scaled on a storey's planview because [S1:yes, yes, because a small model] () an intelligent thing is, for instance () I have a project's floorplan and a model of the full volume (-)(.) while I design in the floorplan, while I am {dealing with it}, I have the other magic model as part of the design process	I1 {points} at the printed plan view. I1 {points again} at the printed plan view. At the sentence {dealing with it}, I1 holds his head as indicating a mental process. I1 {indicates the screen} as an aid during the student's work on the printed plan view.	 {I1 points again}
S2 we would have to see if it works	S1 laughs.	 {I1 indicates the screen}
I1 well yes it works (.) in order to develop a project properly, beyond the technical problems.		 {dealing with it}
---End of the dialog---	S1 puts the laptop aside and the critique continues without the use of augmented reality tools.	

Group 2 – AR-based dialog 1 (00:03:34)





	Dialog	Gestures	{Screenshot}
	---Beginning of the dialog---	This dialog is the beginning of a design critique for the group 2. Is focused on the setup of the AR models on the screen and how the technology operates.	 
I1	Yes yes yes yes (.) wait wait		
S1	(-) is going well, a (red model) [I1: ok, ok] (-)		
S2	(let's see)	Both student and instructors are {watching at the AR model} in a laptop screen {held by S2}.	
S1	move it a bit		
I1	excuse me		
S1	yes (9)	I1 takes the marker and starts moving it, {overlapping} the 3D model with the {printed floorplan}. S2 tries to {modify the AR scene} in order to improve the visualization of the 3D model. During the pause (9) students mix several spare words (not audible due to overlaps) to make fun of the situation of holding the laptop to visualize the model properly.	
I2	you know, that you can eventually use a webcam?		
S1	eh		
I2	so you don't need to	“eh” in approval tone.	
S2	yes		
I1	you have to (-) so the model (fits) (.) good (10)		

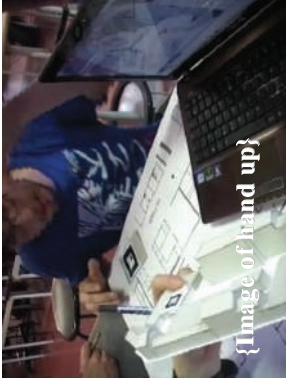
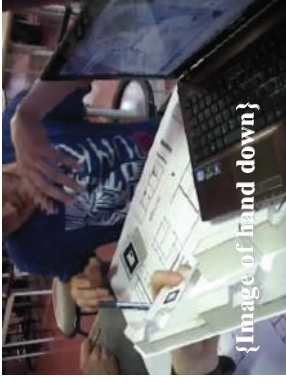

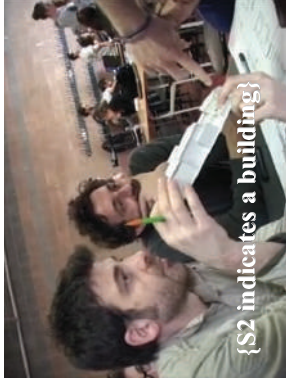
I3	(but) did you try it?	S2 checks in the screen the location of the model while S1 keeps holding the laptop. I3 question is referred to create an attempt of the AR model prior to the design critique.		
S1	at some point we tried			
I1	well, a more or less, but we can see it (.) a model	I1 is still staring at the screen and now continues manipulating the marker around the printed floorplan. {S3 indicates} him where the 3D model is supposed to fit with the floorplan. {S2 places} the marker properly {in the floorplan}.		
S3	but this is the model			
I1	a, so it (fits) ok (8) at this point can you move it? i mean, the point of view?			
S1	yes, well	{S1 starts moving} the laptop in order to show the 3D model from a different perspective while still aligned with the floorplan.		
I1	i mean moving the camera, no no don't (do it now)			
I2	yes but you can just rotate the marker and move the marker around (.) if you want to see the building from			
I1	yes yes but in relation to the plan (.) i was asking myself why it doesn't keep the position on the map [S2: is not about the quality of the model]	{I1 rotates the marker} in front of the camera.		
I2	ah, it is very strange	{I1 overlaps} the marker with the floorplan again.		


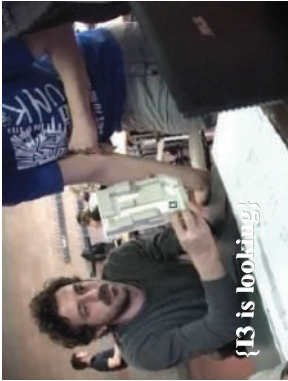
I1	yes but if you position it in the correct (while he moves the marker around)	<p>{I1 makes a gesture} indicating the precise position in which the marker should be.</p>		
S1	yes, maybe also it's (-)			
I1	yes but that is a problem of the model's visibility, the position, the georeferencing of the model. Also you didn't place it in the correct point, even if it is difficult I cannot see it here	<p>{I1 keeps moving the marker} in the same plane as the floorplan, while speaking.</p>		
S2	yes but that is (.) maybe there is a reflection on the program when the marker is being held like this and then is (more difficult to watch -)	<p>{I1 indicates the floorplan}.</p> <p>{S2 holds the marker} in such position that a reflection appears on the camera.</p>		
I1	i see (4)	<p>{I1 holds the marker} in the same position S2 just did and then {S2 indicates} him that the light might be a cause for the AR display issues.</p>		
S2	maybe you see how (to hold it)			
I1	yes yes of course, there is a light			
S1	(-)			
I1	ok, it's fine, but this is left for the revision using this model that does (not fit with the map), is a disappointment (-)			

S1	yes we understand (but we preferred) to make a volumetric model, a 3D (that fits with) the floorplan (-)	<p>{S1 answers} while still holding the laptop, keeping the 3D model visible all the time during the dialog.</p> 
I1	ok (1) I can maneuver the model anyway, eventually	
	---End of the dialog---	

Group 2 – AR-based dialog 2 (00:02:51)


Dialog	Gestures	{Screenshot}
---Beginning of the dialog---		 {another marker}  {I1 and students}
I1 Ah! {Another marker}! [S1. yeah] Can we use this? (4)	This dialog is embedded within an ongoing critique and begins when students show a new, augmented model explaining their project. {I1 and students} give a look to the mode, on-screen.	
S1 What (.) (-) yes (.) I can hold it [S2 & S3:(-)] Yes	Several short dialogs between students to discuss how to display the model properly while {S2 picks the laptop}.	
I1 How do I do this		
S1 Yes yes yes yes (more or less like this) (3)		
I2 You can always move the model, isn't it this here?	"it" is referred to the 3D model being loaded into the marker Speaking to S2, who is holding the laptop.	 {S2 picks the laptop}
S1 exactly (2) Lower the computer	Students added a cardboard slip to the marker to hold it on the top of the physical model. {I1 observes} the model on-screen, manipulating it by hand	
I1 Ah OK (1) well done adding this cardboard slip		 {I1 observes}
S2 yes yes		
S1 Then we can substitute it (like this) (-) (5)	"Substitute" seems to be referred to	

S2	It works	changing the 3D model to be loaded in that marker. S1 makes a quite interesting gesture while saying this, holding his hand in the air and moving it from the head to the printed model, as if he would be transferring something (repeats it twice): {Image of hand up} {Image of hand down}	 {Image of hand up}  {Image of hand down}
I1	it works very well [S1 & S2:(-)] the scale is very easy, having a model 1:500 makes the simulation very (-)	The end of the sentence has a positive intonation, not audible though.	 {I1 keeps manipulating}
S2	but when we do (the model) maybe (-) the webcam (-) we could understand more		
S3	when we were testing (-) the model was white for me	students are explaining with a set of quiet, low volume comments the technical challenges of using the tool to display their 3D model.	
I1	Well but like this we can still understand it	{I1 keeps manipulating} the model in front of the camera.	
S3	We can understand [S2. We are]		
S2	substituting a building (-)	{S2 indicates a building} in the model while I1 manipulates the physical model in front of the screen.	 {S2 indicates a building}
I1	How did you create this kind of hallway (2) free of any shelter		
S1	eh		

I1	I understand little, for example, of how the quantity of program was redistributed. This part here, very wide, and (-) shelter.	<p>I1 switches to make use only of the physical model, but it still contains the marker though {I1 indicates} specific parts of the physical model while making his comments.</p>	
S3	Yes, but by doing it like this we wouldn't propose the markets [S2. (-)] because of the access (-)		
S1	When you arrive, you arrive at a building of 6 storeys in a space of 60 sqm, it is (-)	<p>S2 indicates the floorplan. {I3, even if silent, is looking} at the AR model on the screen while the critique continues</p>	
I3	(-)		
I1	Only because as a preliminary conclusion (-) a kind of macro-redistribution (-) at least (-).		
	---End of the dialog---		




List of codified incidents in the data

Student begins by {placing} the laptop’s webcam on an appropriate position to visualize the marker on the top of a printed floorplan. With {additional support of the instructor} he begins to explain the project.



Codified as:

Organisational (spatial) setup of the critique

S1	So, we have tried to highlight the distinctive character of the (.) of the (.) (tradition) (.) with this building, based on the only point in all this square. We haven’t seen a space where every building	S1 {points} the screen. “Point” is referred to a plan view of the building, of pointy-like shape.	
I1	But this is an image that you are using to show this (.) is not	I1 {points at screen} as the mean to place an image. In the meantime S2 {moves some markers} in the space in front of the camera.	 

Codified as:

Student-instructor interaction using the AR model (by pointing it)



Codified as:

3D Image display in the AR model

S2 {moves the markers around} in front of the camera.



Codified as:

Student-model interaction with the AR model by moving it

S2 { moves the markers around } in front of the camera.



Codified as:

Curiosity/novelty driven display of the AR model by student

I1	But this is an image that you are using to show this (.) is not
S1	Yeah, it is difficult (.) to associate a model

Codified as:

Student remarks on technical (software) issues

S1	Yes yes, only that (.) But as a first time is still going well (8)
S1	(-)

{ Both S1 and I1 hold again the laptop } in order to visualize the models properly on the top of the floorplans. Student stops talking and laughs at the situation. The pause of 8 seconds is due to I1 checking the model on the screen. I1 realizes that the model {is not properly placed} according to the marker's coordinate system.

Codified as:

Student-instructor interaction using the AR model (by moving it)

I1	Because you could have placed the image here [S1: the slope is always different so] (.) Yes because you could (- way out)
----	---

I1 {points at the printed sheet}.



Codified as:

Instructor-student interaction using the physical model (by pointing at it)



Codified as:

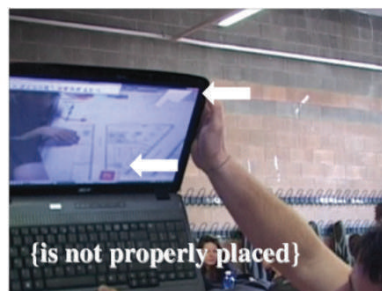
Physical/digital overlay

I1	Ah, is in the wrong place
S1	Now (.) the limit of the computer
I1	I will hold the computer, come on

I1 realizes that the model {is not properly placed} according to the marker's coordinate system.

Codified as:

Instructor-student interaction using the AR model (manipulating the marker)



Codified as:

Technical problem regarding the location of the digital model in relation to the marker

I1	I will hold the computer, come on
	---End of the dialog---

S1 tries to push a key in the laptop and the computer almost fell. The rest of the group of student laugh at the situation, they stop the critique for a couple minutes to do some technical adjustments in the AR model.

Codified as:

Organizational (spatial and roles) setup of the critique

S1	because it is useful as a solution but
I1	No, no, because you can have (an attempt) scaled on a storey's planview because [S1:yes, yes, because a small model] (.) an intelligent thing is, for instance (.) I have a project's floorplan and a model of the full volume (-)(.) while I design in the floorplan, while I am {dealing with it}, I have the other magic model as part of the design process

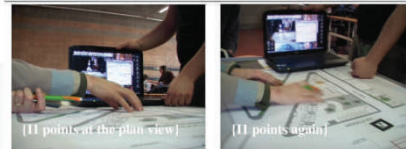
Codified as:

Usefulness of AR for modelling

because it is useful as a solution but
No, no, because you can have (an attempt) scaled on a storey's planview because [S1:yes, yes, because a small model] (.) an intelligent thing is, for instance (.) I have a project's floorplan and a model of the full volume (-)(.) while I design in the floorplan, while I am {dealing with it}, I have the other magic model as part of the design process

I1 {points} at the printed plan view.

I1 {points again} at the printed plan view.



Codified as:

Instructor-student interaction using the printed floorplan (by pointing at it)

At the sentence {dealing with it}, I1 holds his head as indicating a mental process.
I1 {indicates the screen} as an aid during the student's work on the printed plan view.

S1 laughs.



Codified as:

Mental engagement with the design process (gesture)

while I design in the floorplan, while I am
{dealing with it}, I have the other magic model
as part of the design process

Codified as:

Speculative applications of AR for designing



Codified as:

Instructor-student interaction using the AR model (by pointing at it)

S2	we would have to see if it works
I1	well yes it works (.) in order to develop a project properly, beyond the technical problems.

Codified as:

Technical problem regarding the AR-based overlaps

This dialog is the beginning of a design critique for the group 2. Is focused on the setup of the AR models on the screen and how the technology operates.

Both student and instructors are {watching at the AR model} in a laptop screen {held by S2}.



Codified as:

Physical setup of the design critique

Codified as:

Organizational setup of the design critique

I1 takes the marker and starts moving it, {overlapping} the 3D model with the {printed floorplan}. S2 tries to {modify the AR scene} in order to improve the visualization of the 3D model. During the pause (9) students mix several spare words (not audible due to overlaps) to make fun of the situation of holding the laptop to visualize the model properly.



Codified as:

Instructor's interaction with the AR model by manipulating the marker

Codified as:

Troubleshooting by modifying the AR scene during the critique



Also codified as:

Student interaction with the digital model only

I1	excuse me
S1	yes (9)
I2	you know, that you can eventually use a webcam?
S1	eh
I2	so you don't need to
S2	yes
I1	you have to (-) so the model (fits) (.) good (10)

Codified as:

Dialogue on technical hardware issues (webcam)

“eh” in approval tone.

Codified as:

Positive standpoint towards the AR model

I1	you have to (-) so the model (fits) (.) good (10)
----	---

S2 checks in the screen the location of the model while S1 keeps holding the laptop. I3 question is referred to create an attempt of the AR model prior to the design critique.

Codified as:

Organizational setup of the design critique - designated screen holder

I1	a, so it (fits) ok (8) at this point can you move it? i mean, the point of view?
S1	yes, well
I1	i mean moving the camera, no no no don't (do it now)
I2	yes but you can just rotate the marker and move the marker around (.) if you want to see the building from

Codified as:

On the use of the software to create AR scenes

I1 | a, so it (fits) ok (8)

Codified as:

Positive comment
towards the AR model

I1 is still staring at the screen and now continues manipulating the marker around the printed floorplan. {S3 indicates} him where the 3D model is supposed to fit with the floorplan. {S2 places} the marker properly {in the floorplan}.



Codified as:

Student-instructor
interaction by using
the AR model (by
manipulating the
marker)



Codified as:

Instructor-student
interaction by
manipulating the
marker



Codified as:

Instructor-student
interaction by
overlapping the
marker with a printed
floorplan

I1	i mean moving the camera, no no no don't (do it now)	{S1 starts moving} the laptop in order to show the 3D model from a different perspective while still aligned with the floorplan.
I2	yes but you can just rotate the marker and move the marker around (.) if you want to see the building from	{I1 rotates the marker} in front of the camera.
I1	yes yes but in relation to the plan (.) i was asking myself why it doesn't keep the position on the map [S2: is not about the quality of the model]	{I1 overlaps} the marker with the floorplan again.
I2	ah, it is very strange	

Codified as:

Questioning about the
technical capability of
the AR model keeping
the location

Also codified as

Dialog on the
construction of the AR
model and
physical/digital
overlaps

I1	ok, it's fine
----	---------------

Codified as:

Positive comment
towards the AR model

I1	yes but that is a problem of the model's visibility, the position, the georeferencing of the model. Also you didn't place it in the correct point, even if it is difficult I cannot see it here
S2	yes but that is (.) maybe there is a reflection on the program when the marker is being held like this and then is (more difficult to watch -)
I1	i see (4)
S2	maybe you see how (to hold it)
I1	yes yes of course, there is a light

Codified as:

Troubleshooting the
visibility and location
of the digital model in
the marker



Codified as:

Instructor-student
interaction whilst
manipulating the
digital model (marker)

I1	yes yes of course, there is a light
----	-------------------------------------

Codified as:

The model in relation
to its physical
environment

I1	ok, it's fine, but this is left for the revision using this model that does (not fit with the map), is a dissapointment (-)
----	---

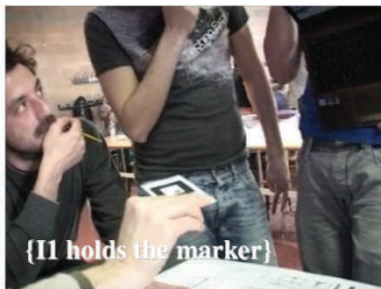
Codified as:

Negative attitude
towards an
unfinished/unsuccessf
ul AR model

S1	yes we understand (but we preferred) to make a volumetric model, a 3D (that fits with) the floorplan (-)
I1	ok (1) I can maneuver the model anyway, eventually

Codified as:

Technical solution to the software constraints by building a massing model



Codified as:

Manipulation of the AR model

Students added a cardboard slip to the marker to hold it on the top of the physical model. {I1 observes} the model on-screen, manipulating it by hand



Codified as:

Curiosity-driven manipulation of the AR model

{I1 and students} give a look to the mode, on-screen.
Several short dialogs between students to discuss how to display the model properly while {S2 picks the laptop}.



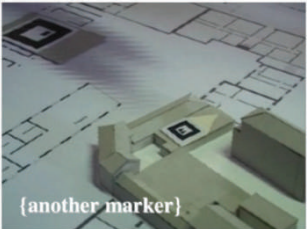
Codified as:

Unplanned display of the AR model by students

I1	it works very well [S1 & S2:(-)] the scale is very easy, having a model 1:500 makes the simulation very (-)
S2	but when we do (the model) maybe (-) the webcam (-) we could understand more
S3	when we were testing (-) the model was white for me

Codified as:

Software use for the authoring and display of the AR scene



Codified as:

Change on the organization (roles) of the group of students





Codified as:

Instructor
manipulation based on
the directions given by
students



Codified as:

Instructor
manipulation of the
marker

students are explaining with a set of quiet,
low volume comments the technical
challenges of using the tool to display their
3D model.

{I1 keeps manipulating} the model in front
of the camera.

Codified as:

Organization of the
physical layout of the
design critique

{S2 indicates a building} in the model while
I1 manipulates the physical model in front
of the screen.

S2	but when we do (the model) maybe (-) the webcam (-) we could understand more
----	---

Codified as:

Solution to a physical
(hardware) problem to
visulize the AR model

marker. S1 makes a quite interesting gesture
while saying this, holding his hand in the air
and moving it from the head to the printed
model, as if he would be transferring
something (repeats it twice): {Image of
hand up} {Image of hand down}



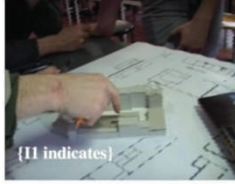
Codified as:

Students intent to
display thoughts into
an AR model

I1	Well but like this we can still understand it
S3	We can understand [S2. We are]

Codified as:

Positive attitude
towards the scale
1:500 of the model

I1	I understand little, for example, of how the quantity of program was redistributed. This part here, very wide, and (-) shelter.	I1 switches to make use only of the physical model, but it still contains the marker though {I1 indicates} specific parts of the physical model while making his comments.	
S3	Yes, but by doing it like this we wouldn't propose the markets [S2. (-)] because of the access (-)		

Codified as:

Speculation about the
applicability of 1:500
models in an AR scene

I2	You can always move the model, isn't it this here?
S1	exactly (2) Lower the computer

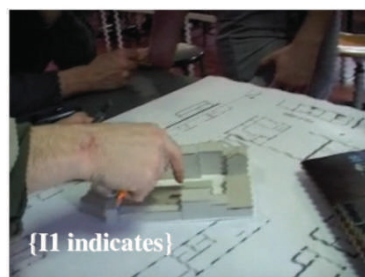
Codified as:

Technical challenges
related to the model
on-screen display
Instructor
manipulation of the AR
model by visualizing
and rotating the
marker

S3	when we were testing (-) the model was white for me	students are explaining with a set of quiet, low volume comments the technical challenges of using the tool to display their 3D model.
----	---	--

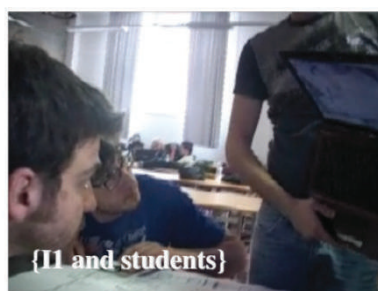
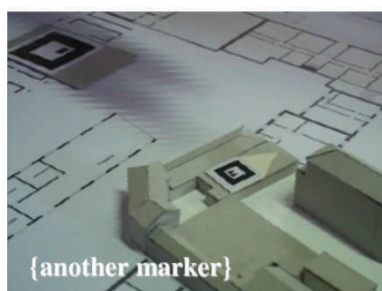
Codified as:

Readability of the
model based on its
colour



Codified as:

Instructor interaction
with the physical
model by pointing at it



Codified as:

Student interaction
with the AR model by
manipulating /
visualizing it on screen

I1	I understand little, for example, of how the quantity of program was redistributed. This part here, very wide, and (-) shelter.
S3	Yes, but by doing it like this we wouldn't propose the markets [S2. (-)] because of the access (-)
S1	When you arrive, you arrive at a building of 6 storeys in a space of 60 sqm, it is (-)
I3	(-)
I1	Only because as a preliminary conclusion (-) a kind of macro-redistribution (-) at least (-).

Codified as:

Architectural program being visualized through the AR model



Codified as:

Instructor interacts with the physical massing model



Codified as:

Student interaction with the physical model by indicating it

S2 indicates the floorplan. {I3, even if silent, is looking} at the AR model on the screen while the critique continues



Codified as:

Curiosity-driven manipulation of the AR model by an instructor (not within the critique dialog).

Solo interactions	Social interactions	Technology affordances	Troubleshooting	Emotional engagement
Student-model interaction with the AR model by moving it	Student-instructor interaction using the AR model (by pointing it)	3D Image display in the AR model	Student remarks on technical (software) issues	Positive standpoint towards the AR model
Instructor's interaction with the AR model by manipulating the marker	Student-instructor interaction using the AR model (by moving it)	Curiosity/novelty driven display of the AR model by student	Technical problem regarding the location of the digital model in relation to the marker	Positive comment towards the AR model
Student interaction with the digital model only	Instructor-student interaction using the physical model (by pointing at it)	Physical/digital overlay	Technical problem regarding the AR-based overlaps	Positive attitude towards the overlap of the physical and digital model
Curiosity-driven manipulation of the AR model	Instructor-student interaction using the AR model (manipulating the marker)	Usefulness of AR for modelling	Troubleshooting by modifying the AR scene during the critique	Negative attitude towards an unfinished/unsuccessful AR model
Unplanned display of the AR model by students	Instructor-student interaction using the printed floorplan (by pointing at it)	Speculative applications of AR for designing	Dialog on technical hardware issues (webcam)	Positive attitude towards the scale 1:500 of the model
Instructor manipulation of the marker	Instructor-student interaction using the AR model (by pointing at it)	On the use of the software to create AR scenes	Questioning about the technical capability of the AR model keeping the location	Organisational shifts
Instructor manipulation of the AR model by visualizing and rotating the marker	Student-instructor interaction by using the AR model (by manipulating the marker)	Dialog on the construction of the AR model and physical/digital overlaps	Troubleshooting the visibility and location of the digital model in the marker	Organizational (spatial) setup of the critique
Instructor interaction with the physical model by pointing at it	Instructor-student interaction by manipulating the marker	The model in relation to its physical environment	Troubleshooting the physical marker - visibility and lighting of the room	Organizational (spatial and roles) setup of the critique
Student interaction with the AR model by manipulating/visualizing it on screen	Instructor-student interaction by overlapping the marker with a printed floorplan	Technical solution to the software constraints by building a massing model	Solution to a physical (hardware) problem to visualize the AR model	Physical setup of the design critique
Instructor interacts with the physical massing model	Instructor-student interaction whilst manipulating the digital model (marker)	Manipulation of the AR model	Technical challenges related to the model on-screen display	Organizational setup of the design critique
Student interaction with the physical model by indicating it	Instructor manipulation based on the directions given by students	Software use for the authoring and display of the AR scene	Cognitive engagement	Organizational setup of the design critique - designated screen holder
Curiosity-driven manipulation of the AR model by an instructor (not within the critique dialog).		Speculation about the applicability of 1:500 models in an AR scene	Mental engagement with the design process (gesture)	Change on the organization (roles) of the group of students
		Readability of the model based on its colour	Students intent to display thoughts into an AR model	Organization of the physical layout of the design critique
		Architectural program being visualized through the AR model		
		Design issues - program distribution		

APPENDIX III

Sample transcript of fieldwork observational notes at the Polytechnic of Turin

Day 1 - Studio 2 - Recorded on 09th April 2013

General Information: Observations taken in a Studio session at the Polytechnic of Turin, on a studio session of 70 students + 2 instructors + 1 assistant. Third year undergraduate Architecture program.

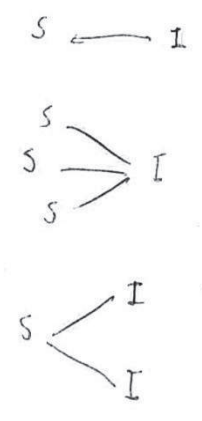
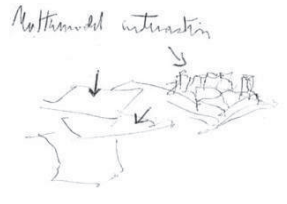
10.05 This studio is a traditional lecture room but students are making use of it as a studio room, in shattered groups around the room (which is very big). Not all of them are working, definitely less computers than in the room of Studio 1. Maybe is not 'correct' to begin with early comparisons but since one session of observations is made right after the other, some comparison is unavoidable.

The instructor (D) said 70 students but now inside the room there might be around 35. Lots of people coming and going.

I ask a student about their critique sessions today. They must present a masterplan - early shape form of a building which operated in a former industrial area in Turin. This studio is supposed to be "technology-oriented", mostly noted in terms of building technologies. As such, at this stage of development there is not so much about a "technical approach to design" to be seen.

As the same as the previous observed session, they are in a stage of master planning and program allocation, and also critiques will be group-based. I can see very 'old-school' A1 size sheets with plans, sketches, sections and elevations.



	<p>There is a critique ongoing (not recorded because I was not there when it started) also making use of aerial photos (isometric view) to describe the place. I can spot some multimodal interaction between the instructors and the groups of students, on what seems to be far more complex than a 1-1 dialog.</p>	
	<p>Also the instructor tends to move across several models to explain one point, making the use of models an extremely difficult and fast sequence to record.</p>	
11.50	<p>During the critique some students are the leaders of their groups. Overall is a very typical group critique session, around 15 minutes each, all in Italian. I note that body language and gesticulation are very important, so video was a nice choice as a data collection method. Next design critique is recorded in video.</p>	

APPENDIX IV

Sample Wiki screenshots. Source: designpedagogy.org

201514ARCH403 - ARCHITECTURAL DESIGN PROJECT

What's New

Module Staff

Sign-ups

Learning Resources

Assessment

Assignment - Project Brief

Training Area

Install Plug-ins and Software

Collaboration

Feedback

COURSE MANAGEMENT

Control Panel

Files

Course Tools

Evaluation

Grade Centre

Users and Groups

Customisation

Package and Utilities


Help

Assessment - Group 1 Wiki

201514ARCH403 - ARCHITECTURAL DESIGN PROJECT

201514ARCH403 - ARCHITECTURAL DESIGN PROJECT

Viewer Comments (4) ^



Aiyuth Sharma 10 months ago


Hey Neil,

Branching out the topics into titles and sub titles seems very much practical but it's not doing wonders on this platform. I'd suggest to please rearrange your pages into just headings to make it more viewable without any branched sub-headings.

Regards

Aiyuth

Reply




Tengcheng Wang 10 months ago

How is going? The Physical Model....

I heard that u will make a PM, I'm really expect it!

Reply



Neil Newitt 10 months ago

Hey Aiyuth and Tengcheng,

It's a fair comment with branching out topics but I think that with the rest of the content to follow it would not be organised enough to simply have topic headings due to complex content. You would have to flick through and read a lot of content to find a specific area. I have looked at other peoples and they don't seem to create the story of the entire process which is what I thought this was all about. I will do move some bits about and get in touch with you for more feedback. Thanks

The physical model is on its way! The construction process we are adopting is a little bit complex so a physical model is the best way forward. It's all getting very exciting!

Thanks for the comments and I will try and give you both feedback also

Regards

Neil

Reply



Meng Li 10 months ago

Your pavilion has a good use of sunlight, to enrich the changes of shadow. But the vertical elements seem like out of control.

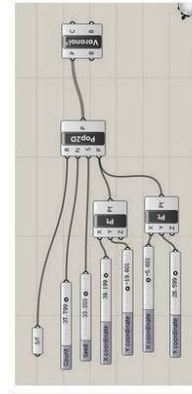
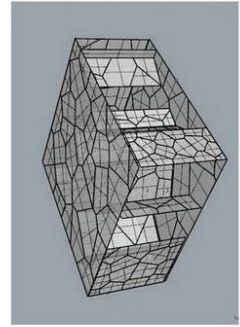
Hide Replies | Reply



Qiaomeng Chen 10 months ago

Yes, and we are trying to improve this part:

Reply



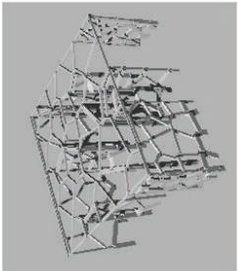
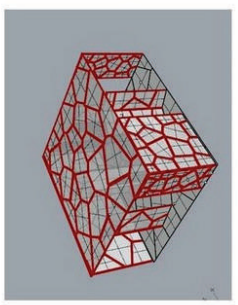
Use the same method to form the facade.



Jinying Li 10 months ago

The traditional element from China is the basic aspect on your project. Perfect. The shadow will be very interesting and rhythmic.

Reply



Huiyang Wang 10 months ago

the third design looks very Chinese style and beautiful. I love it!
the last rhino model has the feeling of the skeleton of water cube in Beijing.

Reply



Zhaoxing Ma 10 months ago

It looks really nice! I just want to know what kind of material you will choose and are there branches will be structure to support this pavilion?

Reply



Yinan Cheng 10 months ago

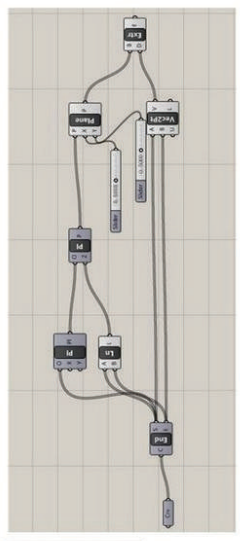
I think you could add some sheltered area because if it is rainy, nobody would like to stay in this pavilion. It must be very wet.

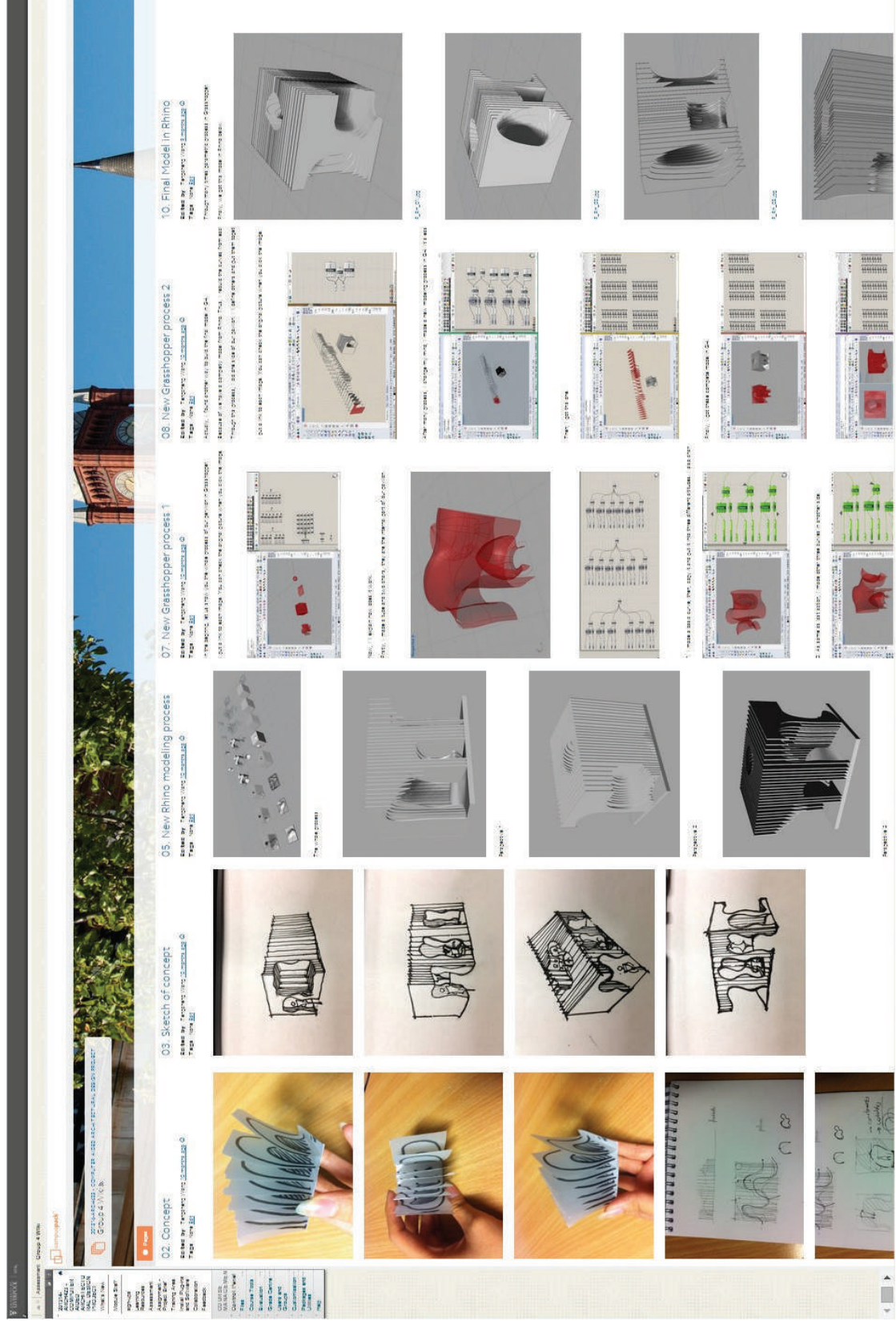
Reply



Fuxing Hu 10 months ago

Very nice idea. But when it is rainy, I think I don't want to stay here.





- 201314.ARCH423 - COMPUTER AIDED ARCHITECTURAL DESIGN PROJECT
- What's New
- Module Staff
- sign-ups
- Learning Resources
- Assessment
- Assignment- Project Brief
- Training Area
- Install Plug-ins and Software
- Collaboration
- Feedback

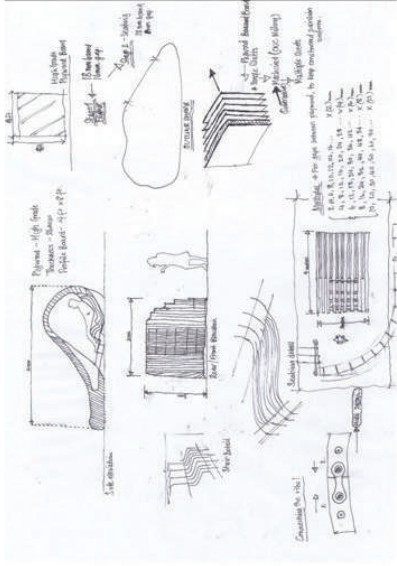
Construction Strategy

Edited by: Neil Hewitt [Read more...](#)
Tags: None [Edit](#)

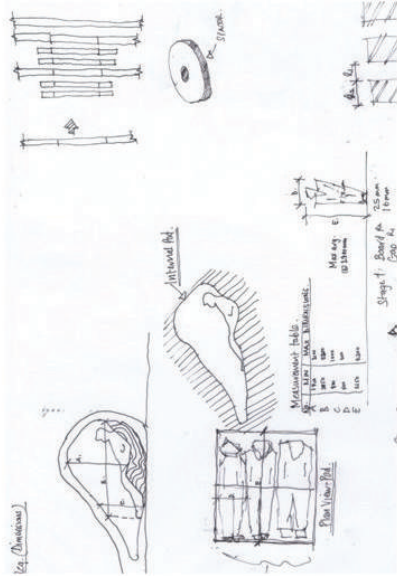
Below is an image of sketches that were put together to show the construction process. This design explores the areas of parametric design used in the commercial market.

We have decided that to construct the pavilion we will create a series of ply board frames that will stand vertically next to each other. At different locations around the pavilion the spaces between the boards will differ.

Here we have used algorithms to shape the pavilion which have led to continuous engineering with calculations of pavilion design and material consumption. The difference in profiles that define the pavilion interior and exterior enabled us to change the appearance of the entire structure.



- COURSE MANAGEMENT
- Control Panel
- Files
- Course Tools
- Evaluation
- Grade Centre
- Users and Groups
- Customisation
- Packages and Utilities
- Help



Viewer Comments (2)

- Terrence Tula 10 months ago

Hey guys, it seems you started with a detail and thorough analysis of space and structural elements. Jump to Bruno and Gert to speed time and come up with the desired design development.

Show Replies (1) | Reply
- Vicci Xu 10 months ago

It's really different with others, you group considerate the load. However, do you think carrying the load is a big issue of this pavilion? How the load influence the whole structure?

Reply
- Add Comment

in #1 B Z U

Add

APPENDIX V

Ethical considerations during fieldwork research

Ethics of the design studio as a research fieldwork

The role of the informants is crucial to depict communication in the studio environment following an ethnographic approach. In educational research, however, there is a delicate balance to be kept in order not to interfere with the informant's educational processes whilst conducting a thorough investigation of the observed phenomena. This tension has been addressed by a series of ethical guidelines that stress the need to respect such balance, as well as to promote and secure the integrity and quality of educational research. The responsibilities to participants, to sponsors, to the community of educational researchers and to educational professionals, policy makers and the general public are the headlines under which ethical guidelines are drawn in the publication "Ethical guidelines for educational research" from the British Educational Research Association (BERA, 2011). The responsibilities to participants are, nevertheless, those having a direct impact upon the utilised methods and research techniques during fieldwork. The following considerations are drawn upon the responsibilities to participants recommended by BERA (2011), yet situated in the context of architectural design studios and my own experience as educator and researcher.

Voluntary informed consent

The informants of this research participate assuming two different roles: passive and active participants. The observation of design critique sessions considers the participants as passive, as they do not individually provide data for the theory construction but instead, observations are focused on a collective activity. Still, a voluntary informed consent was put in place and every member of the observed communication dynamics have been informed about the aims of this work before the observation sessions were conducted.

Accessing the informants

As previously reviewed, the design studio has a distinctive culture (Cuff, 1991) and fosters a sense of community along its participants, promoting the transit of students from novice to expert designers (Dutton, 1987). This principle was not only useful to set a disciplinary frame for this work, but additionally served me as a resource to place myself as a participant observer (Gold, 1958) in the field. Given my experience as a design instructor for some years before conducting this research, I am able to identify the cues, cultural principles and conventions of the design studio. An illustrative

example of this is the technology inductions, in which students were introduced to the different observed technologies before the observation and recording sessions. Regardless the variety of the design briefs, some common principles of architectural design education (e.g. the construction of models) and previous works (e.g. already developed AR visualisation resources for design) served as exemplary illustrations for students to understand the operation and applications of such technologies.

The gathering of information during fieldwork involved groups of people, as well as individual insights and interviews with the participants of the design studio courses. It has been documented how ethnographic data shifts across different social situations which shape the participants' responses (LeCompte & Goez, 1982). For instance, it has been reported how informants' answers during interviews change in nature when interviewed individually or in groups (LeCompte & Goez, 1982) - a phenomena which was here observed whilst conducting interviews with students and groups of students on the use of Wikis. For such reason I placed myself in a constant back and forth between the observation of group activities and group interviews, as well as individually provided information. This confirms the initial observations from Eisendhart (1989) who promotes the use of several interrelated methods and techniques to more thoroughly depict the observed phenomena, and those observations from Glaser & Strauss (1967) who state that those different "slices of data", when combined, contribute to the total picture of the social setting.

Privacy of the informants

There are, however, situations in which informants have provided personal insights and accounts of their work, after a voluntary informed consent. Regardless the research setting, BERA is clear on the need to follow the United Kingdom (UK) guidelines for ethical research in international contexts whenever the research is conducted by UK-based researchers (2011). Semi-structured interviews with students require their active role as informants for data collection. Despite some of this information is publicly disclosed by informants - for instance, their background and motivations are usually disclosed during Universities' entrance interviews and tests - those interviews remain here anonymous. In specific descriptions of situations and incidents, and upon their approval, instructors' background and teaching approaches are described in detail. Groups of students, however, change constantly across the different observed design critique sessions and their identities are not relevant for interpretative purposes at this

stage. Only for descriptive purposes, names have been modified. Likewise, during the monitoring of on-line students' communication, their identities remain anonymous and the only distinction made throughout the data transcripts is that of "students" or "instructors". Lastly, a need for anonymity is present in the last stage of this work, during interviews with instructors. Questions were directed towards their assessment practices and their understanding of the role of learning technologies. The identities of those instructors remain anonymous after their ethical approval to conduct such interviews.

Dual role - teacher and researcher

As a participant observer, I was an active member of the observed design studios. My role shifted across those of teaching assistant or guest instructor and therefore I was perceived as a teacher by the students. Given that studios usually operate with a team of instructors rather than a stand-alone lecturer, my role was not perceived as anomalous, and my own social ties with the members of the studio followed that of a student-instructor relationship.

Moreover, my focus on the observation of technology-enhanced learning was always aligned with the design brief and learning outcomes of the observed courses. Coincidentally, my observations have been made in courses which precisely aim to increase the technological skillbase of students and therefore the technology induction sessions and subsequent observations were commonplace. For instance, my initial observations of AR technologies in a design studio were conducted in the MSc Digital Architectural Design at the University of Salford, a course in which inductions to new tools and resources were rather frequent and as such, the usual pace and delivery of the courses was not severely disrupted by the use of AR technology.

Incentives

Throughout this research no incentives have been put in place for the participants, on an attempt to let them freely use the observed technologies in a more open, exploratory way when required. Exceptionally, in the case of the students' using Wikis to support their design work, the construction of the on-line records is a requirement from the studio instructors, although no assessment criteria were related to the communication dynamics found in the Wiki sites for the purpose of this research.

Detriment

The observed technologies have been taught to the whole observed studios, yet its use remained on a voluntary basis. This action was taken in order not to produce a detriment on students' work, as some might see the technology induction as a desirable intervention that could put some students - those not going through the induction sessions - in an unadvantageous position.

Disclosure

Beyond the scope of this work, most design instructors acting as informants have requested a copy of the published work arising from this research. This condition is also present in the specific University of Liverpool Ethical Consent Form and is to be pertinently addressed. Ethical considerations are to be maintained in such communications.

APPENDIX VI

Interviews with design instructors - Questionnaire

1. Background questions

Name / Studio teaching experience

How would you describe your teaching approach?

How would you describe the relevance of models and representations in such approach?

Have you been in the need to incorporate technologies into your studio teaching? If so, how? Do you make use of any pedagogical resource?

2. Technology-enhanced learning

Could you please describe how you usually conduct a design critique session? Could you give an example of it?

What does the concept “technology-enhanced learning” mean to you?

What makes a modelling tool a “learning technology”? Can you give me an example?

Do you consider the use of tools and technologies for design as a tacit student-driven activity, or is it required by you?

Which are the core benefits that you can identify after the use of representation and communication technologies?

3. Assessment

Could you please describe, as a procedure, how you conduct a project's assessment - how do you judge?

Which is the relevance of models and representations for such judgement?

Do you use any pedagogical resource for assessing studio projects?

Is there any relationship between the quality of the project (in terms of design) and the quality of the visualisations and representations?

Which are the key questions and challenges you face when assessing a project?